THE

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THE

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## STANDARD BOILER TESTS.

WHEN, in 1885, the American Society of Mechanical Engineers brought forward their code relative to a standard method of conducting steam boiler tests, they probably did not realise how very general would be its acceptance by the mechanical engineers. But this American code was well received, because it was a fairly practical and common sense one. The rating of boilers was fixed in terms of horse-power, but the horse-power was fixed as the capacity to evaporative 30 lbs. of water per hour at 70 lbs. pressure from a feed at 100° F., which is equivalent to an evaporation of 34½ lbs. from and at 212°. This standard is equal to 33,305 thermal units per hour. While getting this figure, it would seem to have been desirable to fix upon a boiler horse-power as 33,000 units, an exact multiple of the foot-pounds in the mechanical horse-power, thereby correlating the two coefficients. The committee of revision of the 1885 code has accepted the old standard, differently stated, however, at 34½ lbs. evaporation, which is equivalent to 33,317 thermal units per hour. Any boiler so rated is held to be capable of performing its rating when fired by an ordinary fireman with the best coal ordinarily sold in the market where the boiler is located. Moreover, forcing must not be necessary, but the boiler, when forced, must show one-third more output, the draught not being less than ½ inch water column.

The revised code is too lengthy for reproduction. The two ordinary methods of starting and stopping a test may be given.

The "Standard" method is that wherein at a given moment the grates and ash-pits are cleaned bare and a new fire started with weighed wood and coal, noting time and water level while the water is quiescent. At the end of the test the fire is again removed when low and the water level noted when quiescent.

In the "Alternate" method the fires are burned low and cleaned, the water noted, and the time taken. At the finish the fires are again burned low and cleaned and the test finished by observation of water and time.

Both methods are faulty and open to criticism, and we think might be improved upon. We are much inclined to place faith in a recently advocated method which involves no departure from ordinary practice. The test is started at the moment when the pressure gauge begins to move decidedly back after the last previous stoking. This is the moment chosen to mark time and water levels, and at the close of the test the same retrograde movement of the pressure gauge is noted after the last preceding firing and taken as the finish of the test. No attempt is to be made to keep the test to an exact number of hours.

This system appears to us to have much to recommend it, not the least being that the fireman is not put out of his ordinary line of duty. He merely commences upon weighed

coal when notified to do so, the remainder of his preliminary coal being removed.

Where a fireman is accustomed to using coal from a large heap we think that where circumstances permit, the test coal should be weighed out in a large amount to begin with and the balance weighed back after testing.

Where coal is weighed out in driblets during a test it is really very difficult to ensure exact tally, and where it can be had the weighing machine should print each weighing on a ticket, not merely as a check on the weights, but also on the numbers. The weighing out of coal in exact lots of 100 or 500 lbs. is also apt to lead to error. The batches are far better guessed at when the measure is filled up. Less chance of booking a load twice will occur where one weighing may be 117 lbs. and the next is 124 lbs. Two similar weights would not probably come together. It is an easy error to book a weighing twice, but omissions to book are not so easily made. Hence the safeguard afforded by random weights. Engineers accustomed to making practical tests with available apparatus are not usually overburdened with assistants, and in making tests will, of course, delete many of the headings of a full standard method. If one happens to be a professor with any amount of public instruments and appliances and a crowd of students anxious to sweat in the grime throughout a long day's run, then the testing of a boiler may resolve itself into sitting in an armchair and tooting a horn at given intervals the day through. But all are not professors, and must perforce carry out tests and obtain commercially accurate results with ordinary appliances and rigid personal attention.

With regard to the quality of steam produced by a boiler, we are not disposed to place any weight whatever upon the calorimeter method of dryness determination. It is not that we doubt the accuracy of the method and of the instrument; what we do doubt is the fairness of the sample drawn from the main steam pipe. We do not believe there is a known reliable method of drawing samples.

We fear that too many boiler tests are absolutely unreliable, and would be misleading were they not so palpably absurd. Thus one engineer will obtain a certain high evaporative duty, and will record a certain chimney temperature, and account for, perhaps, 17,000 heat units per pound of fuel used, which will be described as dirty slack with 10 per cent. incombustible matter. Another man will make a test and declare a flue gas final temperature less than that of the boiler itself, but he will only show a reasonable rate of evaporation with the best of coal, and one is driven to wonder how he contrived to live in a boiler house which was receiving 15,000 heat units per pound of coal, and only rejecting about 2,000, and utilising, perhaps, 8,000, leaving 5,000 radiated into the boiler house. Yet such inconsistencies are published without a tremor. It is really marvellous. Where tests are being made as between antagonistic parties, it is, of course, often difficult to prevent the presence of such parties. Yet their presence is, as a rule, harmful, disconcerting, and disquieting, and experience tells us that such parties, if present, ought to be gagged for silence and chained to a post. They invariably find fault with whatever method is adopted of doing anything, and if their wishes are acceded to they usually succeed in spoiling the test for themselves, when they turn round and demand the suppression of the figures.

Appendices are added to the report before us dealing with the determination of moisture in coal, of the wetness of steam, and the calorific capacity of the coal. Various apparatus is also briefly described, and the Ringelmann smoke scale is described and illustrated. One of the instruments described and illustrated is that very good form of draught gauge which uses a flatly-sloped glass tube as one arm for the U gauge. It is far more accurate, of course, to read a draught gauge in which the water column of, say, half an inch is lengthened out to several inches, the exact proportion depending upon the angle of inclination. The difficulty with these instruments, however, appears to be capillarity, and great diversity of opinion was expressed at a discussion as to their use some two years ago.

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The Economy of Electricity Works.

It is more than likely that the cost of production of electricity may be materially affected in the next few months if the price of coal continues to increase at the present rate. There are pessimists who declare that ordinary household coal in London will touch £3 per ton before the present crisis is past; if this is realised it will be exceedingly serious for ordinary households, and it will be of the gravest importance to electric lighting companies. The present cost of coal per unit in London averages nearly 1d., and it will be readily seen that if coal costs thrice its present price, the handsome profits that one has been accustomed to associate with London companies will be very much diminished. If difficulties do arise on the question of coal, we are afraid that electric lighting concerns (especially when we take into consideration the difficulties of keeping up a supply) will not have a very cheering prospect before them. Such a crisis might not be altogether an unmixed evil, for it might induce more experimenting in the direction of oil-fed furnaces and low class fuels, which have been recently discussed by the Institution of Electrical Engineers.

---

**British Thomson-Houston Company's New Plant at Rugby.**—The New York *Electrical Review* just to hand has the following interesting piece of information:—"It is stated that the British Thomson-Houston Company, one of the foreign branches of the General Electric Company, will erect at once, at Rugby, England, a manufacturing plant to cost about $2,500,000. About 20 acres of land have been secured and plans for the various buildings are now in preparation. The demand for American goods is so great in the British Isles just now that the English representatives of the company petitioned for this plant. Only the smaller machines will be built there, the larger ones being exported from the United States, as is done now. It is not known yet what the plans of the company are with regard to labour to be employed in the British works."

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**The Use of a Trade Name.**—In an article on this subject published in our issue of December 22nd, 1899, we drew attention to the case of the Valentine Meat Juice Company *v.* the Valentine Extract Company, in which judgment was given for the defendants. In referring to a gentleman who had invented a method of making meat extract, which has since become the property of the defendant company, we styled him "an American named C. T. Valentine." We have since been informed by the defendant company that his true initials are "C. R." Valentine, and that he is not an American. He transferred his interest to the company in 1897 and not in 1898, as mentioned in the article. We much regret the error.

## STROBOSCOPIC METHODS OF DETERMINING THE REVOLUTIONS AND SLIP OF SMALL MOTORS, AND THE FREQUENCY OF ALTERNATING CURRENTS.

DR. G. BENISCHKE* has devised some ingenious optical methods of determining the speed of small motors and the periodicity of electric or magnetic cycles. There is no difficulty in counting the revolutions of large dynamo machines where the speed is moderate and the power great, but in the case of small motors the braking action of the ordinary counter or tachometer cannot be neglected. Such, for example, is the case with small motors of $\frac{1}{10}$ to $\frac{1}{4}$ H.P., used for driving ventilating fans. The speed of such motor-driven ventilating fans is measured by Benischke's method without contact with the motor.

The apparatus used is shown in figs. 1 and 2. Upon one end of the axis of a small direct current motor is mounted a

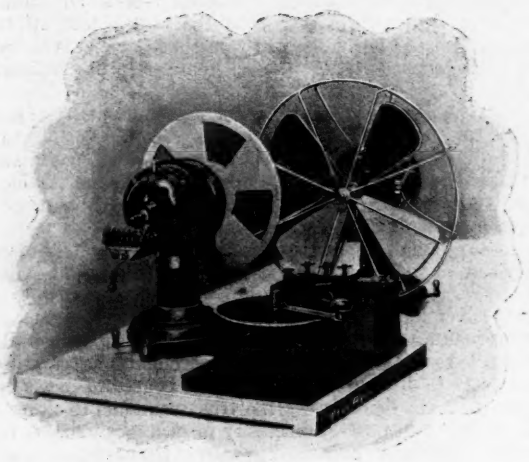


FIG 1.

small disc with radial slits; the other end is furnished with a counting apparatus, which may be thrown into gear by hand. To count the revolutions of the motor-driven fan, the counting motor, placed in front of the fan as shown in fig. 1, is started, and its speed is regulated by a rheostat, till the arms of the fan are seen stationary on account of the well known stroboscopic effect produced when two discs are driven at equal speeds in opposite directions. When this stationary appearance is observed, the counting apparatus is thrown into gear for unit time. The reading is multiplied by the coefficient of the apparatus to determine the revolutions per second of the fan. If the disc contains twice as many slits as the number of arms on the fan, the disc of the counting motor requires to be turned at only half the speed of the fan to obtain stroboscopic agreement. This has to be taken into account in determining the coefficient of the apparatus. If there is no fan on the shaft of the motor to be counted, a disc similar to that on the counting motor may be fitted on it, a star wheel, or the spokes of a belt pulley may be utilised. In general, if $m$ is the number of spokes or slits of the motor to be counted, and $n$ the number of spokes or slits of the counting motor, the revolutions per second of the counting motors must be multiplied by $\frac{n}{m}$ to obtain the required revolutions per second of the motor being counted.

This stroboscopic method can also be used to determine the frequency of an alternating current, even when access to the generator is impossible and no synchronous motor is available. This method is, moreover, more convenient and reliable for counting the revolutions of a rapidly-rotating motor than a revolution counter or a tachometer. The apparatus used is illustrated in fig. 2. In front of an electro-magnet energised by the alternate current whose frequency is to be measured is set up an iron rod which supports a water bottle with an outlet pipe controlled by a cock. If the water is allowed to flow out in a thin stream, and the current is switched on to the electro-magnet, then the jet is broken into drops, one for each wave of the electric current, which imparts a jerk to the vertical rod. Thus the number of drops passing a given point corresponds to the frequency of the alternating current. If this stream of drops is examined through the slotted disc of the counting motor, stroboscopic agreement can be established by suitably adjusting the speed of the disc till the drops appear to float stationary in space. If the speed of the stroboscopic disc is reduced, the drops appear to move slowly downwards; if it is increased, the drops appear to move upwards and flow back into the water tap. When the drops appear stationary the revolutions of the counting motor for a given time are ascertained as above described, and from this the frequency of the alternating current can be deduced by multiplying the number of slits in the disc by the revolutions per second.

Instead of the water jet an arc lamp may be used. The light of an arc lamp fed by an alternating current is, of course, periodic, and a stroboscopic disc illuminated by such a lamp appears to stand still, when the angular velocity of the slits corresponds to the frequency of the lamp current. This effect is best observed by throwing the shadow of the rotating disc on a white wall.

If the stroboscopic disc is mounted on the axis of an alternate current motor driven by the same current as feeds the lamp, the disc will appear stationary if the motor is exactly synchronous. But if the motor has a certain slip the disc appears to move slowly, and the amount of the slip can be calculated by counting the number of slits that pass a given point in a unit of time. The slip can be ascertained much more exactly in this way than by counting the revolutions of the motor and the frequency in the usual way. This

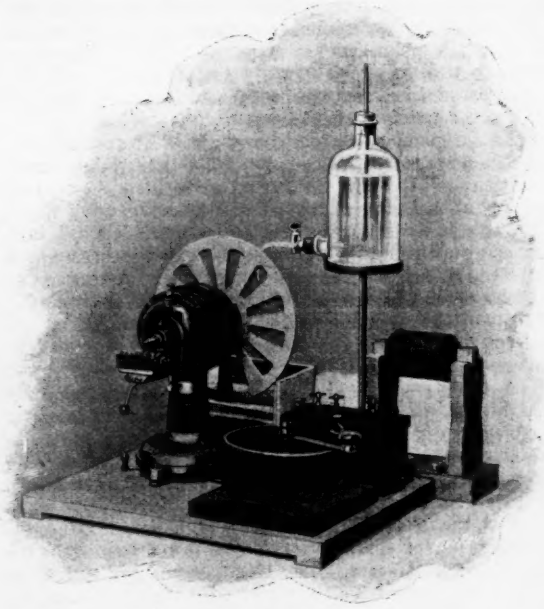


FIG. 2.

will be evident from the following consideration. In order to ascertain the slip of a four-pole induction motor in per cent., the measured number of revolutions has to be multiplied by four, and compared with the frequency. To take a numerical example, let us assume that such a motor makes 1,460 revolutions per unit time, with a current frequency of 6,000, then the slip is

$$\left(\frac{6{,}000}{1{,}460 \times 4} - 1\right) 100 = 2{\cdot}74 \text{ per cent.}^{\dagger}$$

If there should be an error of $\frac{1}{2}$ per cent. in counting the revolutions, which is almost the smallest error possible with

* *Elektrotechnische Zeitschrift*, 20, p. 143.

† Strictly speaking, the slip is $\left(1 - \frac{1{,}460 \times 4}{6{,}000}\right) 100$; the error, however, is negligible when the slip is small.—EDS. ELEC. REV.

the ordinary revolution counter, then the revolutions obtained would be 1,468 instead of 1,460, and the slip would come out

$$\left(\frac{6,000}{1,468 \times 4} - 1\right) 100 = 2{\cdot}18 \text{ per cent},$$

*i.e.*, the slip obtained would be 26 per cent. greater than the true slip, with an error of only ½ per cent. in the revolution counters. In the stroboscopic method, the difference of the speeds, and either the revolutions of the motor or the frequency of the current are ascertained. Taking as an example the four-pole motor, and a frequency of 6,000 as before, the difference of speeds is found by the stroboscopic disc to be 40. Then the equivalent speed is

$$6,000 - (40 \times 4) = 5,840,$$

and from that the slip may be deduced

$$\left(\frac{6.000}{5,840} - 1\right) 100 = 2{\cdot}74 \text{ per cent.}$$

If we assume an error of ½ per cent. in ascertaining the frequency, so that the frequency is really 6,030 instead of 6,000, then the slip is

$$\left(\frac{6,030}{5,870} - 1\right) 100 = 2{\cdot}725 \text{ per cent.},$$

*i.e.*, only ½ per cent. too great. The probable error by the ordinary method of counting revolutions and frequency is thus 52 times as great as the probable error by the stroboscopic method.

## NOTES ON MAXIMUM DEMAND INDICATORS.

By LOUIS J. STEELE, M.I.E.E.

Amongst the various methods at present in use for charging for electrical supply there are none which can be said to be perfectly satisfactory to the supply company, and equitable to the consumer. An excellent compromise is, however, found in the system which allows a discount based on the maximum demand of the consumer. It will be remembered that such a system was devised by Mr. Arthur Wright, chief electrician to the Brighton Corporation, and was first employed at that place with marked success. A proof of its advantages exists in the fact that it has been adopted in a good many towns in this country, and is extensively employed by the Chicago electric lighting companies in America. In August last the Chicago Edison Company had no less than 1,776, and the Commonwealth Electric Company, of the same city, 1,255 Wright demand indicators connected to their respective circuits.

The conditions of electricity supply differ materially from those of gas and water, inasmuch as electricity cannot be stored to any large extent in an economical manner. As a result of this, it is necessary for the generating station to generate at a rate to meet the demand at any particular time. In other words, the plant must be of such a capacity as to cope with the maximum consumption of power, or rather the maximum rate of consumption, which is represented by the peak of the load curve. The standing charges will be in proportion to the size of the plant, and to interest on capital and sinking fund for redemption or depreciation, plus wages, salaries, rates, taxes, &c. It would be superfluous to describe in full the basis of the Wright system, which is now so well known, but it may be stated that the object of the system is that a consumer receives no discount on his bill until he has paid off his proportion of the heavy standing charges incurred in electricity supply, which, in some stations, may amount to 80 or 85 per cent. of the total expenditure.

An essential part of the "Wright" system consists in the use of a "maximum demand indicator." This instrument is connected in series with the customer's meter, and registers the maximum current taken at any time (exceeding 10 minutes) during any month or quarter. The instrument consists of a **U**-shaped glass tube with a third overflow tube connected to it. To the left-hand leg of the **U**-tube is fixed a hermetically sealed bulb, and to its right-hand leg is connected by means of a second bulb the third overflow tube, which is also hermetically sealed. The **U**-tube is filled with a black registering fluid. The former bulb of the **U**-tube has one or more turns of high resistance metal strip wound round it, through which passes the main supply current. The air in the bulb tends to expand, owing to the heat developed by the current passing through the strip, and will drive the liquid up the right-hand leg until it overflows into the third or overflow tube by an amount which is proportional to the maximum current which has passed. A scale placed against this overflow tube shows the maximum current on which the demand is to be based, a second scale indicates the number of units to be consumed during a given period before the rebate is obtained, the two scales depending on one another. The instrument is somewhat sluggish in its action, taking 10 minutes to record the true maximum at any particular time. This is considered a valuable feature, as it prevents the registration of sudden accidental overloads. The Wright indicator would, however, be unable to properly record the maximum of an intermittent load, such as is met with in electric elevator work, as the load would not be at a maximum long enough to heat the instrument up to a maximum temperature, and matters are made worse when, each time the load is cut off, the instrument cools down, and the next time the load is thrown on the instrument has to heat up from its starting temperature.

For the purpose of recording the maximum demand, it is apparent that a registering ammeter recording on a chart might be employed, providing that the recording needle were suitably damped against vibrations, or it might be arranged that the indicator should be maintained in its maximum position by some mechanical device.

Although the method of sending the current through metal strips and employing its heating effect as in the case of the Wright indicator has certain advantages, especially on the score of simplicity, it would appear to be difficult to construct such an instrument to work correctly on a three-wire system to record on a single scale on account of the total effect due to the $C^2 R$ losses in the two strips connected to the two outer wires not representing the true maximum in either of the wires. It would be necessary in such a case to use two separate indicators, connected to each of the outer mains, and even then the sum of their indications would not give the true maximum demand.

A further important consideration in connection with the Wright indicator is that, although it is applicable to alternating as well as continuous current circuits, in the former case it does not take the power factor into account on an inductive load.

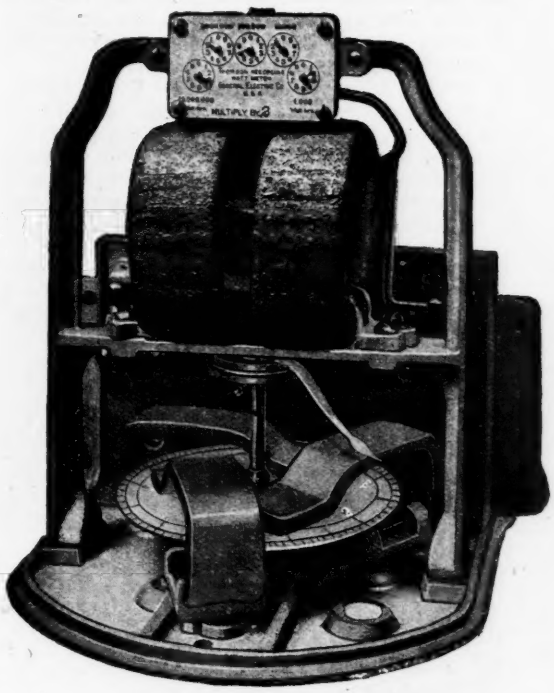
The Halsey maximum demand indicator, illustrated on the next page, is of great simplicity, and has the virtue of forming part of the meter itself; it can easily be designed to form part of most motor meters without interfering in the least with their accuracy of integration. This device possesses several features which do not exist in other systems at present in use.

The principle of the device is briefly as follows:—

The rotating part (or the armature in the case of a Thomson meter) drives the brake portion through the medium of a flexible spring coupling in the spindle, which is severed at that point, a pawl and ratchet serving to prevent relaxation of the spring coupling, and a viscous material being employed at the junction of the two shafts to act as a retarding agent and permit of sluggish action. A pointer is fixed to the upper portion of the spindle for the purpose of recording the angular displacement of the armature relatively to the brake portion. This device is, therefore, virtually a recording transmission dynamometer.

Now, when the motor is running at a certain load and a corresponding steady speed, the resistance offered by the brake is equal and opposite to the torque exerted by the armature; consequently the torsion on the spring coupling will be proportional to this torque, and as the torque is proportional to the load, the torsion on the spring coupling increases in direct proportion to the load. This will hold good under all conditions, even if the retardation is greatly increased by abnormal friction in the rotary portion, or should the speed have altered owing to the weakening of the permanent magnets. In such cases the motor would run at such a speed that the total resistance offered to rotation would balance the torque exerted by the armature. In other

words, the torsion on the spring coupling is proportional to the torque exerted by the armature, and independent of speed of rotation. This will be seen from the fact that even though the brake disc were held in a stationary position the torque exerted by the armature at a particular load would be accurately registered on the indicator.



HALSEY MAXIMUM DEMAND INDICATOR.

About the only thing which would cause a failure in the indicator would be the breaking of a wire in the armature or in its resistance, thereby weakening the torque, or opening the armature circuit altogether, which is not of common occurrence.

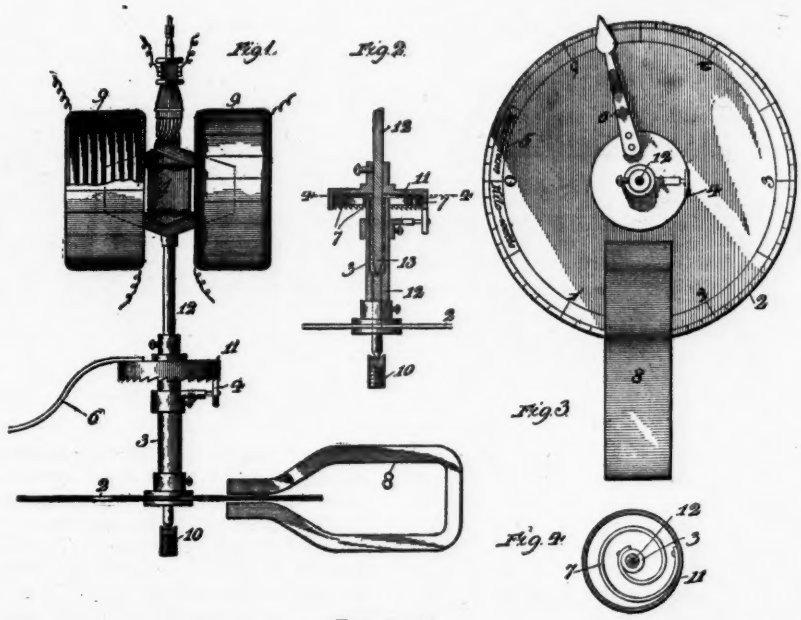
on it, showing also the indicator 6, the ratchet wheel 11, the gravity pawl 4, and the magnet 8.

The method of attachment of this device to a motor meter is best shown in fig. 2. The shaft is cut in two, about ½ inch above the brake disc, and to this latter portion is fixed the sleeve 3, the end of the upper portion of the spindle terminating in a point 13. This part of the shaft is perfectly free to turn in the sleeve and has fixed to it the flanged ratchet wheel 11, which in turn is coupled to the top of the sleeve 3, through the medium of the spiral spring 7, which is best seen in fig. 4. In this manner the upper or armature portion is flexibly coupled to the lower or brake portion.

The proportions of several features are somewhat exaggerated in the illustrations for the sake of clearness of illustration. In reality there are about 300 teeth in the ratchet wheel. The space is quite clear between the shaft and the sleeve, the spring is thin and long and the index finger is thin and flexible, so that it can be sprung down to the scale to obtain an accurate reading; for the purpose of rendering the device sluggish, and to prevent sudden brief overloads from registering, a small quantity of a viscous material is inserted in the sleeve, and the end of the upper spindle is pushed down into it.

This material is of such a consistency that it will not ooze out if the meter should be left standing in an inverted position, being held by capillary attraction in the space between the sleeve and the shaft. It produces no positive friction, but acts as a retarding agent, allowing the indicator to reach its maximum effect in from three to five minutes. It does not alter in character with time, and if desired, its degree of viscosity can be altered. The material has, further, the advantage of acting as a dense lubricant, preventing positive friction to such a degree that the torque of the starting coil of a Thomson meter is sufficient to make a definite indication. This is partly due to the fact that the middle bearing has but half the weight on it that the bottom one has, but yet it is interesting to note that the indicator will move with less torque than is required to revolve the brake disc. The increase in weight to the revolving parts in the case of a Thomson meter is only 4 per cent.

A good point about the device is the large range obtained; for instance, in a 50-ampere 115-voltmeter the scale is 15 inches long, divided into equal divisions of 1 KW. each, each division being sub-divided into 100-watt divisions.




FIGS. 1 TO 4.

Fig. 1 shows the essential working parts of a Thomson integrating wattmeter fitted with the attachments for a maximum recorder shown in detail in fig. 2.

Fig. 4 shows the details of the flexible coupling, being a section through the dotted line 4—4. Fig. 3 is a plan view of the copper brake disc 2 with the kilowatt scale marked

The maximum indication at full load for this meter would be 115 volts × 50 amperes = 5,750 watts, or nearly one revolution of the pointer in relation to the scale. The instrument, however, will register correctly an overload by starting on a second lap. The scales are always adjusted so that full load is less than the first lap.

D

The recorder is guaranteed to have no greater error than the meter to which it is attached.

The instrument is readily set back to zero by holding the pawl with one finger and moving the pointer back to zero, it not being necessary to wait for it to go back of its own accord. The device can be tested at the same time with the meter proper, and can be readily adjusted by lengthening or shortening the spiral spring by its outer end.

The above device is perfectly accurate on three-wire circuits, making the saving of two individual maximum meters, and what is of greater importance, showing the actual maximum, whether the maximum is alternately shifted from one side of the circuit to the other or not.

On alternating circuits, whether single-phase or polyphase, the device will record the true maximum load, as the watt-meter to which it is attached takes the power factor into account.

The device will register the full maximum of intermittent loads, such as in elevator work. Whenever it is given an impulse, it will at least make a notch and hold it, and not drop back to its former position each time.

Amongst the advantages of the device it should be remembered that it causes no drop of potential, and that it is not subject to the destruction of its main parts from the sudden excessive heat of a short circuit.

A method was suggested by Mr. R. P. Wilson in a paper read by him before the Northern Society of Electrical Engineers, March 8th, 1897, for combining a maximum demand indicator as an integral part of an ordinary meter, and which is based somewhat on the above principle. Mr. Wilson describes his instrument as follows :—

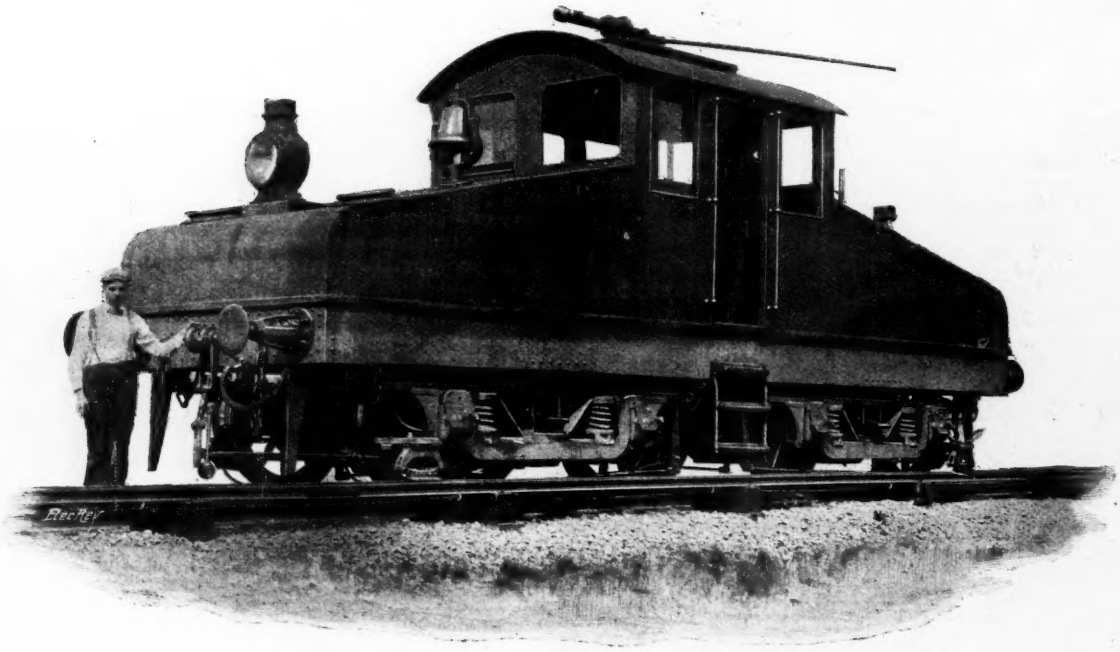
"Instead of having two separate instruments to buy and keep in stock you have only one, and, of course, only one to fix. This instrument serves the purpose also of an indicating meter, and is provided with a pointer, from whose position the rate at which the meter is registering may be ascertained. In addition to saving the loss in E.M.F. inseparable from Wright's indicator, a considerable saving is effected by only having one instrument to calibrate; there is also only one instrument to get out of order. The principle may, with more or less ease, be applied to any motor meter, and is really a torque indicator applied preferably to the existing retarding mechanism. In the case of the Thomson meter, the magnets which provide the brake are suspended, and their motion is opposed by a flat spiral spring. The torque between the disc and the magnets is proportional to the energy passing through the meter, so that the ultimate position of the frame supporting the magnets constitutes a measure of the rate at which the meter is registering. A loose pointer, mounted coaxially with the magnet frame, serves to show the maximum speed the meter has attained, and consequently the maximum demand. The sluggishness of the Wright indicator has been extolled as a virtue, but it is questionable whether it is so altogether. In the combined meter and indicator some care has been taken to avoid sluggishness, except to a very limited extent, although it can be made to work as slowly as may be desired."

Although the device proposed by Mr. Wilson has the advantage of possessing two pointers, one recording the maximum demand, and the other the rate at which the meter is registering, it is doubtful whether its working would be found accurate in practice, owing to the friction produced at the bearings supporting the necessarily heavy weight of the permanent magnets. This disadvantage does not exist in the Halsey maximum record indicator.

## ELECTRIC LOCOMOTIVE FOR PARIS.

We illustrate herewith an electric locomotive which was built for the Compagnie Française Thomson-Houston, of Paris, by the General Electric Company, of Schenectady.

The electrical equipment of this locomotive consists of two 165-H.P. geared motors mounted on each of the two specially designed trucks, making four motors in all, capable of developing 660 H P. The cab contains a Thomson-Houston series parallel controller, also ammeters and circuit breaker, and a number of special instruments, as the locomotive is intended for testing purposes. The controller is so arranged that the engine driver can face in either direction. There is a direct connected air pump for operating the air brakes. The motor resistances are placed under the end shields on the floor of the locomotive. The total weight complete is about 35 tons.



**Bedford.**—The Town Council has received a communication from the Local Government Board sanctioning the borrowing of £41,000 for electric lighting purposes.

## ACETYLENE GAS CONSIDERED COMMERCIALLY.

By HORACE ALLEN, C.E.

ACETYLENE gas as an illuminant is so efficient and attractive that even the general public have taken a great interest in the question of adopting it on account of its pleasing qualities.

Though this gas has attracted so much attention of late, and such rapid advances have been made in its practical commercial application by ingenious inventors, still, owing to its so recent introduction at a cost comparable with other sources of illumination, its adoption on a commercial scale can hardly be considered very much in advance of the experimental stage.

Acetylene gas, when properly applied for illuminating purposes, has many special advantages. The light is very brilliant and pleasing to the eye, and can be produced with great steadiness. The heat given off from the flame is much less than from ordinary coal gas for the same lighting power. Colours are seen in their natural hue under this source of light.

Its high heating power can be used for the illumination of incandescent mantles and for cooking purposes, as it can readily be adapted for use with Bunsen burners. By the use of special burners it can be applied to all purposes for which coal gas is available. The intensity and purity of the light obtainable from the burning of acetylene gas places it outside any competition from petroleum as a source of illumination.

The production of acetylene gas occurs when calcium carbide is brought into contact with water, and when the gas is to be employed for lighting and heating, this must be carried out in a suitable apparatus, commonly called a generator.

The chemical action of the production of acetylene gas is explained by the following formula :—

| Calcium carbide. | | Water. | | Slacked lime. | | Acetylene. |
|---|---|---|---|---|---|---|
| $Ca\ C_2$ | + | $2\ H_2O$ | = | $CaO,\ H_2O$ | + | $C_2\ H_2$ |
| $40, 12 \times 2$ | | $2, 1 \times 2, 16$ | | $40, 16, 1 \times 2, 16$ | | $12 \times 2, 1 \times 2$ |
| 64 | | 36 | | 74 | | 26 |

The decomposition of calcium carbide by water is accompanied by the generation of a considerable amount of heat, owing to the combination of the liberated calcium with oxygen from the water to form lime, and this lime becomes hydrated when the water is in excess.

1 lb. of calcium carbide $CaC_2$ has in combination—

·625 lbs. of calcium.

·625 × the thermal value due to the combination with oxygen and hydration = ·625 × 6,615 = 4,134 B.Th.U.

And this amount of heat may have a very serious effect, unless there is present a considerable excess of water.

Acetylene gas is commercially derived from the decomposition of carbide of calcium by water, and it therefore follows that the cost of acetylene gas will depend upon the cost of carbide of calcium, as the other costs of production are trifling.

Calcium carbide is a compound resulting from the chemical action between lime and carbon at the high temperature of the electric arc, and its production as a commercial product depends upon cheap electric power.

The chemical reaction taking place in the manufacture of calcium carbide is represented by the following formula :—

| Lime. | | Coke. | Heat. | Calcium carbide. | | Carbonic oxide. |
|---|---|---|---|---|---|---|
| $Ca\ O$ | + | $3\ C$ | 5,972° F. = | $Ca\ C_2$ | + | $C\ O$ |
| $40\ 16$ | | $3 \times 12$ | | $40\ 12 \times 2$ | | $12\ 16$ |
| 56 | | 36 | | 64 | | 28 |

From which a simple calculation will show that to produce 1 lb. of calcium carbide there will be required—

Lime ... ·875 lb.
Carbon ... ·562 „ = coke with 90 per cent. C. ·624 lb.

*Thermal Chemistry of the Production of Calcium Carbide.*

The specific heat of lime and coke may be taken at—

Lime ... ... ... ... ·214
Coke ... ... ... ... ·200

The temperature of the electric arc is estimated as 5,972° F.

To bring the materials for the production of 1 lb. calcium carbide to the necessary temperature will therefore require—

Lime ·875 × ·214 × 5,972 ... ... ... = 1,118 B.Th.U.
Coke ·624 × ·200 × 5,972 ... ... ... = 745 „
To reduce lime to calcium and oxygen = ·625 × 5,940 ... ... ... ... ... = 3,712 „
To raise the thermal value of the carbon as coke to that of carbon in a gaseous condition ·562 × 3,956 ... ... ... ... = 1,483 „
Heat from formation of CO = ·187 lb. × 4,327 ... ... ... ... ... ... = 809 „
Total heat required per lb. $CaC_2$ ... ... = 6,249 „

This heat being derived from electric energy, and 1 E.H.P.-hour being equivalent to 2,536 B.Th.U. per hour, this gives, to produce 1 lb. of calcic carbide, 2·464 E.H.P.-hours, which is equivalent to 1·838 Board of Trade units; one ton of carbide being therefore produced for 4,117 B.T.U.

*Heat of Chemical Combination of 1 lb. of Substance.*

| | | |
|---|---|---|
| Carbon as coke ... ... ... | 14,544 B.Th.U. | |
| Carbon in gaseous condition ... | 18,500 „ | |
| Calcium to lime ... ... ... | 5,940 „ | |
| 1 E.H.P. ... ... ... ... | 2,536 „ | per hour. |
| 1 Board of Trade unit ... ... | 3,398 „ | |

*Estimate of Cost of Materials and Electrical Energy required to Produce 1 ton of Calcium Carbide.*

To produce 1 ton of calcium carbide, practice requires:—

| | | | |
|---|---|---|---|
| Since 1·2 tons of lime are equivalent to 3,500 lbs. limestone, 2·143 tons of limestone at 10s., crushed ... ... | £1 | 1 | 5 |
| ·8 ton of coke at 20s., crushed ... ... ... ... | 0 | 16 | 0 |
| 4,117 B.T.U. + 15 per cent. = 4,734, at ·131d. ... | 2 | 11 | 8 |
| Carbons for electric furnace ... ... ... ... | 1 | 0 | 0 |
| | £5 | 9 | 1 |

The above value of the B.T.U. is based on some figures of best results of actual cost by water-power compiled by J. B. C. Kershaw.

| | | | |
|---|---|---|---|
| Labour, oil, waste, &c., interest and maintenance ... | £3 | 16 | 4 |
| Total cost per ton ... ... ... ... ... | 9 | 5 | 5 |

An examination of the above figures will make it apparent that the only item that can be reduced is that due to the cost of electrical energy, and this is the highest item; for it will not require much consideration to make it apparent that the labour, oil, waste, interest and maintenance costs, cannot readily be reduced, one reason being the fact that the calcic carbide has to be packed in fairly small quantities in hermetically sealed tins, barrels, &c.

In this article the lowest cost of electrical energy to be obtained from natural sources has been taken as a basis for computing the cost per ton to manufacture calcic carbide, but now that blast furnace gas has become available, the manufacture can be carried out with profit at less cost than when the cheapest water-power is used.

Taking the figures already quoted, viz., ·131d. per B.T.U., this at an efficiency of 70 per cent., is equivalent to ·0684d. per I.H.P.-hour when a gas engine is employed and blast furnace gas used instead of water-power.

Now, as each ton of coke charged into the blast furnace for smelting the iron produces about 170,000 cubic feet of gas, and only about 130 cubic feet per hour is necessary to develop the 1 I.H.P.-hour, the value of the gas, after cleansing, comes to ·52d. per 1,000 cubic feet, if employed to develop power by means of a gas engine, while if burned in the flues of steam boilers, the value would be reduced to ·13d., as at least four times the quantity is required for developing power by steam boilers than when used direct in the gas engine.

At 170,000 cubic feet per ton of coke, the gas, if entirely consumed in gas engines, would therefore have a value of 7s. 4·4d. Of course, this amount cannot be realised, for many reasons. In ordinary blast furnace practice about one-half of the gas is required for heating the air blast, and if we say that leakages and loss bring this amount up to two-thirds of the total gas evolved, the remaining one-third being employed in gas engines working continuously, as at present for steam raising, then the relative value of the gas per ton of coke charged would be as follows :—

| | s. | d. |
|---|---|---|
| If used in gas engines, per ton of coke... ... | 2 | 5·4 |
| „ steam boilers, „ ... ... | | 7·3 |
| Balance in favour of gas engines ... ... ... | 1 | 10·1 |

And with this gas, for each ton of coke consumed in the blast furnace, the power developed in the gas engine would be about 430 I.H.P. hours,

Blast furnaces, consuming as they do such enormous quantities of coke and limestone, and producing such volumes of gas, are ideally favourable to the association of the manufacture of calcic carbide; and the Thwaite-Gardner system is in actual use for this purpose in Westphalia. The materials necessary would be available at the cheapest rate, power at the lowest cost, labour of a suitable kind easily obtained, and railway sidings convenient for the delivery of the product to the best market, while the cost of supervision would be very slight. And all these advantages can be obtained without any large capital outlay such as is necessary when the power of natural waterfalls is harnessed for the production of the necessary electrical energy.

No doubt in the near future ironmasters will avail themselves of this source of profit, seeing that the demand for calcic carbide is favourable, and the price obtainable is so high.

## ELECTRICIANS WORKING AND FIGHTING IN THE PHILIPPINES.*

By HARRY A. ARMSTRONG.

MANILA, October 30th.—D. T. Flannery is a private in the Signal Corps, and he is of many years' standing. He has grown grey in the service, and has reached the distinction known as a first-class private. But he never saw a hotter time than on the south line during the first few days of this month. It was when the insurgents were very bold there, and were cutting the wire between Imus and Bacoor at their own pleasure.

The breaks were always in the vicinity of the "big bend" of the Imus River, and it became Flannery's business to see that the wire was in working order, and that communication with Manila was kept intact. There were a few days when nothing happened, and it was thought to be a good time to put in a telephone system at Imus, connecting the headquarters with the different points of official importance about the town. To get the wire and instruments the lineman came into Manila. He took back with him Private Frank R. Beale, of E Company. The boat was then running to Bacoor, so they loaded their wire on the launch and went across. From Bacoor the two Signal Corps men took a little cart and drove to Imus. Nothing happened on the way, and the beautiful road round the "bend" seemed to hold nothing more dangerous than a frightened carabao.

The men reached Imus about 1 o'clock, the journey by land and water having taken four hours. Flannery reported to Major Price, commanding the troops at Imus. He was given a horse, and told to place the instruments. This was accomplished by 3.30 o'clock. About this time two companies of the Fourth Infantry that had gone out on a reconnaissance got into an engagement. Flannery was on a horse, and he rode out to where the fighting was going on. There he met Major Price, and offered to do any work that might be wanted. Major Price told the soldier to report to Captain Browne, then in charge of the fighting. Captain Browne made him mounted orderly, and sent him all about the field with orders. At last the insurgents were driven away, and the fight was over.

Beale heard the fighting and started out on foot. He got there and was ready to do anything needed of him. But he was not mounted, and about all he could do was to admire "Pop," as Flannery is known to the men.

Major Price and Captain Browne were so well satisfied with the thoroughness of the Signal Corps man and his work that both took occasion to tell him that he had done well. This opinion they later embodied in a report to the commanding general—which was more to the point.

As soon as the fighting was over the men went back to fixing the telephone. They kept at the work until October 2nd, when they again heard firing out towards the east, and bullets came thick into the town. It was discovered that the linemen were in the zone of fire, but they did not stop work. They connected the offices of head-quarters with the adjutant's place and then with the arsenal. It was just at this time, the hour being about 11 o'clock in the forenoon, that the order came to Flannery to take some help and repair the telegraph line in the vicinity of the "big bend." Flannery took Private Beale, two Chinese carriers, and an armed sentry, and set off for the break. It took them half an hour to get there.

When they got near the place they overtook an infantry company and scouts from the Fourth, stationed at Imus. Twenty men were sent along as an escort. Before reaching the break the insurgents opened fire and drove the guard back to the rear and the main column. The situation was critical. The officer in command of the troops wanted to know if Flannery had an instrument by which he could receive and send messages.

"I have not," said Flannery, "but I can send the message to Imus, sir, if necessary. If the current isn't too strong," he continued, "I can receive messages through my tongue."

Flannery took two ends of the wire and sent the first message. He merely tapped the ends of the wire together, making the dots and dashes. The ground end was twisted around a bayonet, which was thrust into the earth. But this sort of thing was too strong for the tongue, as Flannery found when he received the "O K" from the operator at Imus. Two bayonets were thrust into the ground, and so the current was divided. But still it was too strong for the lineman. He could send, however, and he did send another message by tapping the ends of the wire together in the code of dots and dashes. The "O K" he received through his hands. The current was strong enough for that.

The messages had asked for reinforcements, and soon a company of the Fourteenth came up from Bacoor, and shortly after a like number of soldiers came from Imus. With this force it was deemed practicable to fix the break. Privates Miller and Barrett had joined Flannery and Beale, and they all went out to do the work. Flannery was making a rapid tie when the company of the Fourteenth swung around and uncovered the position of the signal men. Then the company unceremoniously marched off to Bacoor and called to Flannery, asking him to tell the company of the Fourth that they had gone. The signal men now were without support and fully 400 yards ahead of the trenches of the troops which stuck to the field. They were much closer than that to the insurgents. In fact, the voices of the insurgent officers were heard giving orders and the insurgent soldiers were in plain sight across the river. Flannery thought it was time to retire. The bullets were coming thick and close to his little bunch of men. He hastily completed the tie and threw the coil of wire across the road and fence so that it could be pulled into the trench. Then he told the men to get to cover. When the men cleared the fence the volleys came at them. Private Beale stumbled headlong. Flannery caught him and helped him on into the trench and comparative safety. Then it was discovered that Beale had been shot in the leg. A call on Imus was made for an ambulance, and Flannery turned his attention to his wounded companion.

Heavy volley and line firing was heard in the direction of the bend. Suddenly Lieutenant Cunningham sprang into the trenches. Behind him came Sergeant Brown. Both were of the Signal Corps. Cunningham was on foot, his horse having been shot from under him as he passed the bend and exposed himself to the insurgent fire. They had come from Bacoor. Flannery reported at once to the lieutenant and told him of the wound Beale had received. Then the ambulance came and the old lineman took the wounded man back to Imus. When Flannery reached there it was 6 o'clock, and he remembered that he had had no dinner.

Cunningham stayed on the ground, sending Sergeant Brown to Imus for a coil of wire. It was his intention to run the wire past the bend in the night, but it started in to rain and the night was too dark to work at all. The work was done in the morning, but the connecting wire was run behind the hedge of bamboos that fringes the road. Helping him the lieutenant had, besides Brown, Sergeant Berry, and Privates Whitcomb and Guswaler.

That day the troops came down and flanked the enemy and drove them south, taking possession of the trenches that had been occupied by the insurgents and planting them with American outposts. This was on October 3rd. The day before Corporal Gunderson had been mortally wounded at that place.

"Pop" Flannery is now on the north line, and has been selected to go with General Lawton on his march north.

* From the *Chicago Record* (reprinted in the *Western Electrician*).

## ENGINEERING IN THE UNITED STATES NAVY.

THERE is little doubt that the engineer is rapidly bringing most human operations within his sphere of influence. He is not only performing work that one associates rather with the industrial development of the world, but he is rapidly becoming an important factor in those offensive operations which aim at the destruction of human life. Both the navy and the army may be said to depend for their well-being upon the engineer, and even in warlike procedure on land engineering work is quite indispensable, and, curiously enough, it is the engineering branch of the army which has had the distinction of producing some of the most famous generals of the present day. Having regard to the engineering side of naval and military operations, the recent presidential address of Rear-Admiral Melville before the American Society of Mechanical Engineers on "Engineering in the United States Navy," is a specially interesting one. It is not necessary to follow the worthy president in his remarks upon the origin of steam vessels, but it is worthy of note that the first steam war vessel for any navy was designed by Robert Fulton, and was built in America in 1814. It was anticipated that if the war with England had lasted a little longer, it would have been possible to have used this vessel, and no doubt it would have created a complete revolution in naval architecture. It was not until 1836 that a chief engineer was appointed for the American Navy, and the steam vessels of the navy in those days consisted of one small boat of 1,200 tons displacement. One cannot help feeling a distinct sympathy with the older generation of engineers, who had no experience, no books of reference to guide them in meeting the problems of those days. Engineers occasionally forget the very early and useful work carried out by naval engineers during the early introduction of steam vessels into the American Navy, and the work of B. F. Isherwood, carried out in 1844, is very properly, highly valued in the States. Probably one of the most notable of his experiments was the series which gave a complete demonstration of the relation between cylinder condensation and the rate of expansion. As Rear-Admiral Melville points out, until these experiments were carried out, most engineers believed that the law of Mariotte—that the product of pressure and volume is constant—was applicable to steam as well as to permanent gases, and that a very large ratio of expansion with low pressure of steam would be profitable. Isherwood's experiments on the *Michigan* demonstrated conclusively that under the conditions there obtained of a slow moving engine and a low steam pressure, a ratio of expansion was soon reached, beyond which any increase would cause an absolute diminution of economy instead of an increase thereto, as would have been predicated from a strict adherence to Mariotte's law. Curiously enough, Isherwood in those early days realised a point in naval design which has been very much insisted upon in later years. That is, the building of engines which would not break down, and, in fact, could not be injured by ignorant and careless handling. The result of this policy was that engines were built very much heavier than was customary; but they did not break down, and they carried American ships to victory. How close a grip Isherwood appears to have had of the essentials of a steam warship, is shown in the case of the *Wampanoag*, which, though built in those early days, was subjected to an excessive trial lasting 32½ consecutive hours, between Sandy Hook and Cape Hatteras, and for the whole run it averaged nearly 17 knots per hour, which was obtained in a heavy sea. It is not surprising that this should have been the record speed for many years. Like a good many other pioneering engineers, he obtained little thanks for the work he did, and though practically banished from his former office as chief of the Bureau of Steam Engineering, he carried out a series of propeller experiments which were of far reaching importance. It is rather a remarkable fact in connection with the American Navy, that their engineering staff has included at some time or other men who have become world-famous in various branches of engineering; Dr. Thurston, Charles E. Emery, William Everett, and George Westinghouse, have all been naval engineers. It is hardly necessary to follow Rear-Admiral Melville through the various evolutionary processes that have been going on for some years in the various navies of the world; but some of his remarks in the address, in connection with the war with Spain, are worth quoting. It is claimed that the work of the *Oregon* in the late war stands out as a brilliant illustration of the fact that the American warship is not only the creature of the engineer, but is absolutely dependent upon him for success. Rear-Admiral Melville relates the story of Milligan's work as the chief engineer of the *Oregon*, of his ceaseless efforts to keep everything in order, and prevent any deterioration, how he saved the good coal for the day of battle, which finally came, although he was told it never could come, and above all, how he persuaded Clark, the commanding officer, to have all the boilers ready all the time, although others had steam on only half the boilers, and where it could be done, half the engine-power was laid off. I am firmly convinced, says Rear-Admiral Melville, that the brilliancy of the victory at Santiago was largely due to Milligan's skill and foresight, and as I have said, this case is direct proof that, however admirable as a great fighting machine, a battleship is useless except in the hands of trained engineers. To quote further from the report:—

During the last 15 years naval engineering has shared in the general progress of all marine engineering, and has led in many respects. Wrought-iron, which was formerly the mainstay of the designer, has practically disappeared, to be succeeded by mild steel, which is not only stronger, but much more reliable, and the manufacture and inspection of which has been brought almost to perfection. There is little doubt that the great improvements which have been made in both engines and boilers would have been impossible but for the greatly improved material. One of the greatest improvements has been made in the reduction of weight of machinery, and this has been due both to improved material and radical changes in design.

In the engine there has been a better disposition of material, and the use of hollow instead of solid shafting and other large pieces of forged material, the use of steel castings, &c., has been instrumental in enabling the use of higher pressures, and particularly of higher rotative speeds. These rotative speeds have become possible since we have learned to design the propellers on rational principles. In the old days the rule was to make a propeller as large as possible, consistent with immersion, and this, on account of the empirical rules for the ratio of pitch to diameter, necessarily kept down engine speeds. Now we know that within reasonable limits we can design a propeller to suit almost any engine speed; consequently we are left free to adopt as high a rotative speed as is desirable and consistent with safety, assured that we can afterwards design an economical propeller to fit it.

In the boilers the reduction of weight has been due, apart from the more recent adoption of the water-tube type, to improved material, and especially to forced draught. This, as you are doubtless aware, is an American invention almost contemporaneous with Fulton's early steamers; but it had almost disappeared, and after a brief revival under Isherwood during the Civil War had again died out until it was taken up by some of the foreign navies. At the present time no naval machinery is ever designed without the use of forced draught.

Pressures have been gradually rising, and even with shell boilers as high a pressure as 200 lbs. has been employed; but with the present plan of using 250 lbs. at the engine, with multiple expansion, and some 25 or 50 lbs. more at the boilers, nothing but the water-tube boiler would do.

## ELECTRIC SUPPLY COMPANY AND CONSUMER.

ONCE more the cry of the consumer is heard in the land! The columns of the *Times* are still open to the complaints of those who feel aggrieved at the charges which an electricity supply company makes for its ethereal wares. In our issue of December 22nd, 1899, we referred to a dispute which has arisen owing to the difficulty experienced by the Metropolitan Supp'y Company in meeting the demands of its numerous and rapidly increasing host of consumers.

According to a "Consumer," whose letter appeared in the *Times* on Christmas Day, one of the electric companies which supply the West End is endeavouring to coerce its consumers to consent to an increase in the pressure of supply, viz., from

100 to 200 volts, and has even gone so far as to threaten to cut off the supply to those customers who offer resistance to their demands. It seems that a large percentage of the company's customers has allowed the change to be made, "in ignorance," as stated by the *Times* correspondent, "that if they object the company has no power to compel them to consent to it."

He also states that in some cases where customers have shown an unwillingness to have any alteration in the pressure of their supply the company has declared its intention of charging the *maximum* rate allowed by the Act, viz., 8d. per Board of Trade unit—an increase of 33 per cent. on its standard rate. In support of his contention that the undertakers cannot force their customers to take a supply at higher pressure, "Consumer" refers to the opinion expressed in the House of Commons by the President of the Board of Trade on June 1st, 1897, where he said, "No change is allowable in the pressure of the supply to any premises which on the date of the Board of Trade regulations were supplied with energy by the company, except with the consent of the consumer."

The importance of the questions thus raised can hardly be over-estimated. Inability to provide *all* their consumers with a current at high voltage may seriously affect the progress of the undertakers, who may be prevented from introducing changes and improvements designed to cheapen supply. On the other hand, the purchase of new lamps, fittings, &c., for his house might entail great expense to the consumer if the life of a high pressure lamp is shorter than that of one which can be lit with a lower pressure.

We have seen that the *Times* correspondent is satisfied with the opinion expressed by the President of the Board of Trade in the House of Commons. Turning to the regulations which were published in 1895, we find that the President, for the purposes of his answer, merely quoted the proviso to Clause (6) of the *Regulations for ensuring a proper and sufficient supply of electrical energy*, published in 1895, the exact words of which are as follows:—"Provided that no change shall be made in the pressure of the supply to any premises which at the date of these regulations are supplied with energy by the undertakers, except with the consent of the consumer."

Assuming that "Consumer's" house was lit with electric light from this very company in 1895, it would seem that it has no power to make any alteration in the pressure without incurring the risk of penalties. To endeavour to force the hand of the consumer would not only be unworthy of a great company but, in our opinion, illegal, having regard to the provisions of Section 19 of the Electric Lighting Act, 1882, which provides against anything in the nature of undue preference upon the part of a supply company. Moreover, the policy of the Electric Lighting Acts is against the imposition of any terms upon the consumer. Thus it is especially provided by Section 18 of the Act of 1882, that the company shall not prescribe any special form of lamp or burner.

It will be gathered from the premises that if the *Times* correspondent and his friends have been receiving electricity at 100 volts since some date prior to that upon which the Board of Trade regulations were issued, they can legally refuse to take a supply at 200 volts. It is otherwise, however, with consumers who have only been in receipt of the current since November, 1895. That the company is *primâ facie* liable to supply every applicant within the district, appears from Clause 25 of the form of provisional order under the Electric Lighting Acts, 1882 and 1888, which provides that "the underwriters shall, upon being required to do so by the owner or occupier of any premises situate within 50 yards from any distributing main of the undertakers in which they are, for the time being, required to maintain, or are maintaining, a supply of energy for the purposes of general supply to private consumers under this order or the Board of Trade Regulations, give, and continue to give, a supply of energy for such premises in accordance with the provisions of the order and of the regulations . . . . subject to the following conditons." Among the conditions which here follow there are none which give the supply company any right to alter or diminish the amount or pressure of the current to be supplied to the consumer, unless he is using his supply in such a manner as to prejudice the interests of other consumers. In 1895, however, the regulations issued by the Board of Trade created some important changes. Thus by Clause (5) it is provided that the standard pressure shall be fixed by the undertakers, and notice of the amount of such standard pressure shall be given to the local authority before the undertakers commence to supply energy to consumers, and such standard pressure shall not be altered *except by permission of the local authority, and upon such terms and conditions as the local authority may impose*, and after public notice has been given during a period of one month, in such manner as the local authority may require, of the intention of the undertakers to apply for permission to alter the same. The undertakers may appeal against any decision of the local authority under this regulation to the Board of Trade, whose decision shall be final. The London County Council being the "local authority" in the county of London, it will be seen that no change can be made without its authority, in the exercise of which the Council would doubtless be influenced greatly by a memorial from the consumers.

By Section B (6) it is provided that "Before commencing to give a supply of energy to any consumer, the undertakers shall declare to such consumer the constant pressure at which they propose to supply energy at his terminals. The pressure so declared at any pair of a consumer's terminals shall not at any time be altered or departed from except in consequence of any authorised alteration of the corresponding standard pressure. In the case of a transformation of energy on the consumer's premises, the undertakers shall give the consumer the choice of a supply at either of two different pressures, one of which shall be approximately half the other, and in such case the pressure so chosen by the consumer shall be the declared constant." [Here follows the proviso already referred to.]

Although a variation of 4 per cent. from the declared constant pressure is allowable, any undertakers who make default in complying with any of these regulations as to supply are liable to pay penalties.

It is difficult to imagine how the company whose alleged misconduct is complained of can have allowed itself to come to loggerheads with its customers, especially in these days of competition. "Consumer" has probably relied too implicitly upon the opinion of the President of the Board of Trade, who may not have had all the facts before him. Even a lawyer is loth to express an opinion until he has perused all the documents in the case, nor does he allow the opinion of a judge to weigh with him until he is satisfied that the facts upon which the judgment is founded coincide with those of the case under his immediate notice.

## CORRESPONDENCE.

### Berrenberg Lamps.

I am sorry the holidays prevented my sending further remarks concerning the test figures you published regarding our 200-volt lamps in time for the issue of yesterday, as I stated in my previous letter I purposed doing. Since writing my letter of the 20th ult. we have ascertained that the identical figures concerning our 200-volt lamps which were given to you are those written down in a book possessed by a rival firm of lamp manufacturers, and by them shown to a gentleman who has had some dealings with the Berrenberg Syndicate. At their invitation one of our 98-volt 18-C.P. lamps was taken to their warehouse to have the same tested for initial candle-power and efficiency. The lamp was placed in circuit with an ammeter which in his presence gave a reading of ·39 ampere—equivalent to 39 watts consumption. Being a lamp of our 2-watt efficiency class, the energy consumed should only have been 32 watts. Our client was then asked to leave the lamp for a day or two, in order that it might be tested at their factory for candle-power. The result of this test when the lamp was returned to him some days later was stated as being 11 C.P. 39 watts, or 3·5 watts per C.P. given.

We have now this identical lamp privately marked by our client in our possession, and while we totally dispute the correctness of the above ammeter reading, and are in the dark as to what treatment the lamp may have experienced between the time it was parted with and when it was returned to the gentleman in question—excepting his statement that he saw with the naked eye that it was not giving so much light as when he handed it over—we challenge contradiction on the following points:—

This very lamp, reported as giving only 11 C.P., gives at the present time 13 C.P. (whatever the treatment it has received since it left our works) and the consumption of energy is not 39 watts but 34 watts.

What value, then, can be attached to figures published which are derived from rival manufacturers, whom at the best no one would expect would be desirous of showing too good results for the "Berrenberg Lamps"?

I invite anybody who doubts the superiority of the Berrenberg lamp over all others to bring what they consider (outside of this make) the best lamps on the market, and at Southfields I am prepared, by testing the rival lamps on the same voltage, photometer, and instruments, to demonstrate to their satisfaction the claims we make.

Thanking you, Mr. Editor, for your kindness in allowing me to trespass so much upon your space—

A. Berrenberg.

*December 30th*, 1899.

[Referring, first, to Mr. Berrenberg's letter of 22nd ult., in which exception is taken to the measurement of candle-power in our tests, we may point out that the photometer used was of the Krüss type, consisting of two similar slabs of opal glass with tinfoil between; the light from the standard lamp falls on one face, and that from the lamp to be measured on the other. The arrangement is very sensitive and quick in use. A pentane standard 1-C.P. lamp was used, in conjunction with a glow lamp as secondary standard; the results were stated in terms of English candles. While the impossibility of obtaining extreme accuracy in the measurement of candle-power is admitted, we cannot agree that our figures are open to question outside a small percentage.

In reply to the letter which appears above, to prevent a possible misunderstanding, we would point out that we did not receive any 200-volt lamps from Mr. Berrenberg's company, nor have we caused any tests to be conducted beyond those of 100-volt lamps, which we published in our issue of the 15th ult.

While we are not disposed to carry out any further tests at present, we appreciate Mr. Berrenberg's sporting offer to allow anyone interested to compare his favourite lamp with the Berrenberg lamp at the Southfields works, with the tempting odds of £100 to nothing for an incentive! We trust that this offer will be taken up, and we shall have pleasure in publishing the results, be they what they may.—EDS. ELEC. REV.]

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### Tested Lamps.

It is not at all strange to put gas in a bulb for "exhausting" purposes, if this is what "F. P. S." means as per Malignani process, but not for "flashing." *

I still assert filaments are not "flashed" in their bulbs, that is to say in a commercial scale, in this or any other country. It is only reasonable, if a broken filament occurred the maker would lose filament, bulb, and labour. I have done it, but only in an experimental way, and have taken the proper precautions to get rid of the remaining gases, which would explode at the ordinary atmospheric pressure, owing to the inrush of air, causing the mixture or removal of the vacuum connections for the attachment for the final "exhaustion." Even then it is far from a satisfactory lamp, as the filament cannot be "run up" or we should produce a considerable deposition of tar, carbon, and other matter on the sides of the bulb; the thicker the filament the greater the defect.

The gas used for depositing carbon during "flashing" must be from one of the family of hydro-carbons or gases containing carbon. "F. P. S." is probably confusing "flashing" gas with "treating" gas, or "exhausting" gas; these latter may or may not be explosive.

I particularly mentioned in my letter "on coming in contact with the blow-pipe flame;" of course it won't explode under the ordinary conditions of "flashing." This is a point "F. P. S." has missed.

Thanks for pointing out one error. In going over the figures I find there is another, that is, an increase of ·1134 ampere, which makes the result worse for the Tested Lamp Company.

"F. P. S." will pardon me. I must correct him again; he has missed the point of contention, that is at the *end* of a lamp's life, not during its life. I am aware during the first few hours of life it does sometimes change slightly, probably owing to contraction of the filament, brought about by the molecules slowly taking up a different position; this is quite common in all kinds of wires, but not, as "F. P. S." stated, due to gas left in the bulb.

Now that we have wandered away so far from the original, and the Tested Lamp Company have not seen fit to take up and explain the peculiar behaviour of the lamps they reported upon, I will let the matter rest, and beg to thank the Editor for allowing me the space in his valuable columns, still maintaining that English made lamps are superior to foreign ones.

English Electrical Engineer.

*January 1st*, 1900.

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I feel much interested in this important question of lamps. I hope Mr. Gattie's greatly distinguished and expert lamp tester, when he shows himself, will not completely annihilate "English Electrical Engineer" (Why slay the brother bore?), as his remarks to me seem to be of some value, and some further information in reference to 200 and 250-volt lamps would be of great service generally to installers.

*Re* testing, it is most unfair to any maker to buy lamps and test them at the marked voltage, as many installers, as well as myself, order lamps to be marked to suit us—for instance, say, 100 volts instead of 107 or 105 volts—because we know in many districts the pressure supplied is considerably above the proper amount. I know of one district where it is as much as 18 per cent. above the proper amount of E.M.F. between certain hours of the day. This means ruination of any self-respecting lamp, as it would convert a 100-volt 16-C.P. at 3½ watts into about 40 C.P. at 1½ watts for the time being. Now, a foreign-made lamp of the usual type 4½ watts per candle-power, of course, can stand it much better.

I know of consumers who refuse to have any other lamps than those stamped with the voltage they are supposed to be supplied with by the supply company.

Now take a 107-volt 16-C.P. at 3½ watts (marked 100—16), run it at 100 volts and we get about 11 C.P. at 4½ watts per candle-power. It looks very bad, but really it was never intended for 100 volts circuit, but one has to please the customer who wants it so. Surely he pays and has a right to have what he wants, and is only exercising his little knowledge; and we must not offend him by telling him so, or away he goes to someone else who panders to his wishes.

It really wants a thorough testing of voltages in all parts of the country at all hours by recording voltmeters. Then another lamp test, but not by the Tested Lamp Company, or any other seller of lamps, but by an independent person above reproach, and apply to all the *makers only* for lamps of a given voltage, given candle-power, at given watts or efficiency within a given size of bulb, all to be in high voltage, say, 200, then see what life and variations of candle-power, &c., we get, just as Sir W. Preece did a few years ago in low voltage.

W. J. Still.

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### The Scarcity of G.P.

In your editorial note *re* "Euphorbia," you did not state what the results of the experiments made were. It would be interesting to hear.

J. E. R.

[No use has ever been made of it in the electrical trades so far as we are aware.—EDS. ELEC. REV.]

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* "Flashing" is a trade term meaning to incandesce a filament in a vapour or liquid, with high or low pressure, for the purpose of reducing its resistance, and to deposit upon it a layer of carbon to a given amount.

### Signalling Without Contact.

I should be much obliged if "C. M. J." would kindly explain why the driver of the Brighton train failed last Saturday to "assume at danger" the Wivelsfield signal which, apparently, was on when he ran past it in the fog.

The collision which occurred with such disastrous effect would appear to most minds to be a most serious condemnation of the present "good" system of fog signalling.

W. S. Boult.

### A Reversible Gas Engine.

I trust you will permit me respectfully to call your attention to a mistake which appeared in your issue of the 22nd ult.

In that issue, in an article on a "Reversible Gas Engine," you gave the names of the patentees as "Fraser and MacDonald," the name Fraser having evidently been inserted by mistake instead of mine, as there has been no other person except Mr. MacDonald and myself engaged on this invention.

I would also like to point out that in the latest design of our engine we combine the operation of shutting off and turning on the gas or oil supply with the reversible handle, so that the operation of reversing resolves itself into a simple to and fro motion of the reversing handle.

John D. Mackenzie.

Glasgow, *December 30th*, 1899.

## BUSINESS NOTICES, &c.

**Alleged Nuisance.**—In the Aberdeen Sheriff Court on 22nd ult. the record was closed in an action at the instance of William Duthie, Banff Villa, Cults, against P. C. Middleton & Co., Schoolhill, to grant interim interdict against defenders from carrying on their works known as Cults Electric Supply Station in such a manner as to cause the chimneys or steam pipes connected with the works to send forth smoke or steam so as to be injurious and destructive to the property and pertinents of pursuer adjacent to the works. The defenders, in answer to the complainant's averments, state that their furnaces are of the best construction for consuming smoke, they are fed with best steam coal, and are carefully fired. The three engines are high pressure, and no appreciable steam is now discharged from the works. The smoke from the furnaces is common coal smoke reduced to a minimum by their construction and careful firing. The new chimney stack erected removed all cause of annoyance either from smoke or steam.

**Annual Festivals.**—The employés and friends of Messrs. Lowdon Bros. & Co. held their annual festival at Dundee last Friday. There were about 200 present.

The annual social entertainment for the wives and children of the employés at the Arc Works, Chelmsford, of Messrs. Crompton & Co., took place last Saturday, about 800 sitting down to tea. About the most prominent feature in the programme was a baby show, for which the Mayoress, Mrs. Reeve, and Mrs. Brunton were judges to award the silver medals offered by Mappin & Webb. A number of large Christmas trees were electrically lighted.

The staff of the North Staffordshire Railway electrical department held their third annual dinner at Stoke-on-Trent on Thursday last week. Mr. John Neale, M.I.E.E., the company's electrical engineer, presided.

**Browett-Lindley Engines.**—Messrs. Browett, Lindley and Co.'s engines are being used in connection with a number of home electric tramway schemes. The Ashton-under-Lyne municipal electric lighting works, which supply current for the Oldham, Ashton, and Hyde line, are equipped with three 300-KW. direct coupled sets, the engines being by Browett-Lindley, and the generators by Messrs. P. R. Jackson & Co. The Douglas Southern Electric Tramways (I.O.M.) have, as part of their equipment, two 150-H.P. horizontal Browett-Lindley engines, driving Westinghouse dynamos. Further, at Salford electricity works, from which current will be furnished for the tramways, there are to be eight three-crank compound engines, each of 1,600 H.P., also by Browett-Lindley.

**Electric Lighting in the Eastern Counties.**—We learn that Messrs. G. N. C. Mann & Co., of Norwich, (who some time since took over the extensive installation department of Messrs. Laurence, Scott & Co., Limited), have been entrusted with the electric lighting of the Municipal Buildings at Bury St. Edmunds. The same firm has also a large number of important installations on hand, including Mundesley Sanatorium, the works of Messrs. Richards & Co., at Lowestoft, Messrs. Miller, Sons, & Co., Limited, at Fakenham, Messrs. Jewson & Sons, at Norwich, the Agricultural Hall and the Royal Arcade at Norwich, as well as many other extensive installations in the eastern counties.

**Electric Cranes.**—The Southampton Borough Council has considered a report from the electrical engineer stating that:—

The cranes on the Town Quay are at present supplied from a separate engine, which is started on notice being given by telephone that the cranes are about to be used. The load on this engine is extremely variable, and there are often considerable intervals during which the engine is running without any load at all. It was therefore proposed to connect the cranes to the tramway system, the load being similar in character to that which will be dealt with in running the electric cars. In order to do this a motor transformer will have to be installed at the Town Quay, as it will be necessary to reduce the tramway pressure of 500 volts to 220, the pressure required by the cranes. Should this method of supply be adopted, the electrical undertaking and the Harbour Board would mutually benefit. The cost of the plant which would be required has been estimated at £785; therefore a reduction should be made in the price paid for current equivalent to about £60 per annum.

It was decided that the Harbour Board should be approached with a view to an arrangement, as suggested, being entered into.

**Fires.**—The premises of the General Electric Company in Sherlock Street, Birmingham, were partially destroyed by fire on Saturday morning. A quantity of valuable machinery was saved. There is nothing to account for the origin of the fire. The property is ensured.

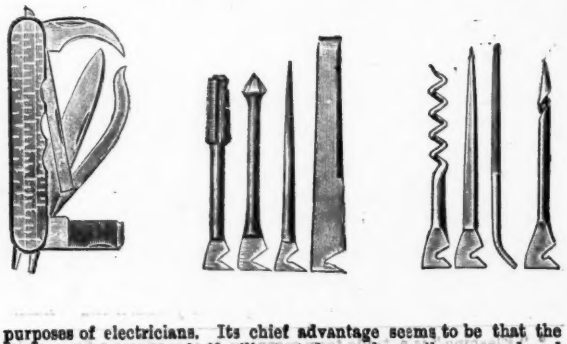
A New York telegram to a morning paper says that on 29th ult. a serious fire broke out during the night at the Campbell Wallpaper Factory. The flames spread to the Manhattan Electric Lighting Company's depôts, and both were practically gutted. The damage is estimated at 1½ million dollars.

**Italian Turbines for Canada.**—The Hamilton Electric Light and Cataract Power Company, Limited, of Hamilton, Ont., is reported to have placed a contract with Messrs. Riva, Monneret and Co., of Milan, Italy, for the supply of two powerful turbines. They are to be each of no less than 3,000 H.P., and to be provided with hydraulic servo-motor and automatic regulator.

**The Lancashire Electric Power Scheme.** — The Lancashire Electric Power Company have deposited a Bill for next session to incorporate a company for the supply of electricity within an area comprising the whole county of Lancashire, excepting that part lying northward of the Ribble. There will be a share capital of £3,000,000, and a loan capital of £1,000,000. The former will be divided into 300,000 shares of £10 each, which may be divided into "preferred half shares" and "deferred half shares." Among the first directors and promoters of the company will be Mr. Walter Bernard Hopkins, Mr. Norman Scott Russell, Mr. Robert Percy Sellon, and Mr. Edward Gripper. The generating stations of the proposed company will be erected in the parish of Aspull, near to the Albion Ironworks, in the parish of Parr, St. Helens, in the parish of Little Lever on lands belonging to Thomas Fletcher & Sons, Limited, and upon a plot of land on the Trafford Park estate. The Bill expressly provides that "nothing in the Act" shall confer upon the company any exclusive rights to supply electricity within the area of supply; nor shall the company "at any time hereafter by reason of any competitive supply be entitled to any compensation." The profits which may be earned by the company are to be regulated by a sliding scale on a 10 per cent. basis—that is to say, that the company are to be entitled to pay an additional 1 per cent. above 10 per cent. in respect of every 5 per cent. charged below the maximum rate allowed by the Bill.

**The Glasgow International Exhibition, 1901.**—The Machinery and Electric Lighting Committee of this exhibition have expressed their thanks for the valuable machinery and plant which had been placed at their disposal for the purposes of the exhibition. It amounts in value, roughly speaking, to over £40,000. The exhibition buildings are making good progress. The one exception is the iron work, but pressure is being brought to bear upon the contractors for this.

**Wireman's Knife.**—We illustrate a wireman's knife for electricians, mechanics, &c., which is being introduced over here by Messrs. Oswell & Strachan, of 37, Lime Street, E.C. This is known as the "Elektron" combination knife and is specially adapted for the



purposes of electricians. Its chief advantage seems to be that the tools as shown in the knife illustrated may be easily removed and others substituted as required. A number of loose tools are furnished with the knives as shown.

## Electrical Wares Exported.

| WEEK ENDING JAN 3RD, 1899. | | WEEK ENDING JAN 2ND, 1900. | |
|---|---|---|---|
| Adelaide .. .. | Value £1,593 | Alexandria .. .. .. | Value £50 |
| Barcelona .. .. .. .. | 10 | Amsterdam .. .. .. .. | 20 |
| Bombay .. .. .. .. | 24 | Bangkok .. .. .. .. | 1,220 |
| Bordeaux .. .. .. .. | 17 | Bombay .. .. .. .. | 27 |
| Calcutta .. .. .. .. | 108 | Boulogne .. .. .. .. | 88 |
| Cape Town .. .. .. .. | 58 | Brisbane .. .. .. .. | 130 |
| Christiania. Teleg. wire .. | 387 | „ Teleph. stores .. .. | 170 |
| „ „ cable .. | 57 | Calcutta .. .. .. .. | 434 |
| Colombo .. .. .. . | 99 | Cape Town .. .. .. .. | 541 |
| Durban .. .. .. .. | 164 | Christiania. Teleg. cable .. | 534 |
| „ Teleg. mat. .. .. | 2,405 | „ Teleph. cable .. | 892 |
| Hamburg .. .. .. .. | 8 | Colombo .. .. .. .. | 31 |
| „ Teleg. mat. .. .. | 110 | Durban .. .. .. .. | 304 |
| Melbourne .. .. .. .. | 105 | „ Teleg. apparatus .. | 974 |
| Monte Video .. .. .. | 536 | Fremantle. Teleg. cable .. | 3,795 |
| Otago. Cable wire .. .. | 250 | Gibraltar .. .. .. .. | 61 |
| Port Elizabeth .. .. .. | 135 | Gothenburg. Teleg. wire .. | 99 |
| „ Pirie .. .. .. .. | 50 | Hamburg .. .. .. .. | 14 |
| Rosario .. .. .. .. | 561 | Hong Kong .. .. .. .. | 590 |
| antos .. .. .. .. | 12 | „ Teleg. cable .. | 830 |
| Spezzia .. .. .. .. | 548 | Lisbon .. .. .. .. | 83 |
| Sydney .. .. .. .. | 170 | Melbourne .. .. .. .. | 343 |
| Trinidad .. .. .. .. | 70 | Montreal .. .. .. .. | 47 |
| Yokohama. Elec. cable .. | 320 | Ostend .. .. .. .. | 116 |
| | | Pasages .. .. .. .. | 24 |
| | | Rotterdam. Elec. light machy. | 1,462 |
| | | St. Petersburg .. .. .. | 75 |
| | | Singapore .. .. .. .. | 44 |
| | | Stockholm. Teleg. mat. .. | 180 |
| | | Sydney .. .. .. .. | 770 |
| Total .. | £7,787 | Total .. | £13,198 |

## Foreign Goods Transhipped.

| | | |
|---|---|---|
| Barbados. Teleph. apprts. | Value | £21 |
| Brisbane. „ „ | .. | 120 |
| Total .. | .. | £141 |

**Bankruptcy Proceedings.**—A receiving order having been made at Greenwich *re* F. B. de Foe Paynter, electrical engineer, of Catford, the first meeting of creditors is arranged for January 10th, at 24, Railway Approach, and the public examination for January 30th, at the Court House, Burney Street, Greenwich. Debts are to be paid to Mr. A. Mackintosh, official receiver, at 24, Railway Approach, S.E.

**Liquidations and Dissolutions.**—Messrs. Nalder Bros. and Co., Limited, met at 101, Southwark Street, S.E., on December 12th and 27th and passed resolutions as follows:—

1. That this company, having attained the object for which it was formed, be wound up voluntarily and that in the distribution of the assets, each shareholder shall receive one share at least in the Langdon-Davies Electric Motor Company, Limited, for each share held by him in this company.
2. That Mr. F. B. O. Hawes be appointed liquidator at a remuneration of £52 10s.

To prevent misunderstanding, we are requested to mention that this is a voluntary liquidation for the purpose of distributing the shares held by the company in the Langdon-Davies Electric Motor Company, Limited. It has no reference to the well-known instrument business formerly carried on at Red Lion Street, Clerkenwell, and now at Princes Mews, Gt. George Street, Westminster.

A petition by a creditor, for the winding up of the Birmingham Carbide Company, will come before Mr. Justice Wright, in London, on January 11th.

Messrs. G. E. Meek and J. T. Davies (Meek & Davies, gas and electrical engineers, 15, Hill Street, Dorset Square, W.) have dissolved partnership; J. T. Davies attends to debts.

**Books Received.**—"Steam Engine Theory and Practice," by William Ripper. London: Longmans, Green & Co. 9s.

"Papers and Reports relating to Minerals and Mining in New Zealand." Wellington: John Mackay, Government printer. 1899.

**Calendars, Catalogues, &c.**—The new year brings with it several handy calendars, &c., from electrical firms. Messrs. Witting Bros., of Cannon Street, have issued an exceedingly neat one with monthly sheets. Process prints of their standard belt-driven three-phase generators, traction motor, and the Heyland motor, are well arranged.

From Messrs. Fuller & Co., electrical accessories and fittings suppliers of Red Lion Court, there comes a handy blotting pad with calendar and memo. diary on the left-hand side.

Messrs. Browett, Lindley & Co. (1899), Limited, of Patricroft, whose name is known to everyone for their excellent engines, have issued a catalogue of illustrations of high speed, self-lubricating and other vertical engines, both simple and compound, and open and enclosed types, for electric lighting and transmission of power. The illustrations are executed and printed in a first class manner. A 1,000 H.P. independent surface condensing plant appears among the other photographic reproductions, also some views of the works' interiors. The list is so arranged as to allow of the insertion of additional lists without trouble. The front cover is commendable as a work of art.

The E.P.S. Company sends one of its very useful desk blotting pads with memoranda book. All who receive this will observe several new features, including a railway insurance coupon.

A pamphlet comes to hand from the National Telephone Company relating to underground conduit developments for electric light, telephone and other wires. The company asserts that it has found multitubular cement blocks to offer so many advantages that it has adopted them in this country and has laid down special plant for manufacturing them in large quantities. The company is now in a position to produce these cement blocks, and to supply them to other consumers. The blocks have been carefully designed for the purpose they have to fulfil. The ducts are stated to be absolutely uniform in bore and the interior surfaces are perfectly smooth and straight, so that abrasion of the cables in the process of drawing in is avoided. For the same number of ducts each block is the counterpart of every other, and they are therefore interchangeable. The company is now drawing the attention of engineers, surveyors, and others interested in the laying of underground electrical circuits to the advantages to be obtained by the use of these conduit blocks. Amongst the foremost of these are mentioned permanence, inertness, compactness, accessibility, convenience, cheapness, &c. The pamphlet before us gives illustrations showing the blocks being laid, gives sectional views of different blocks, and instructions for laying same.

Messrs. Coxon, Schmahl & Burrell, of Grainger Street, Newcastle-on-Tyne, who are the sole agents for electrical accessories, &c., manufactured by Herr J. Buscher, of Solingen, Germany, have sent us an illustrated list of electric bells and accessories. Prices and good illustations appear of trembling bells, the "Monopole" and "Solinga" bells, door and window contacts, and an assortment of fancy pushes.

Messrs. Julius Sax & Co., who have for many years made a great speciality of English electric bells, send us a novel wall calendar for 1900 in the shape of a card representing an electric bell and fittings. We understand that the firm have recently reorganised their business, introducing new capital and the most modern machinery. This has been done so that the company's good reputation for this class of work may be maintained in the 20th century, *when it comes*, as it has been in the past; and, farther, in order that the company may be able to cope with increasing Government orders.

**The Metropolitan Company Summoned.**—At the Marylebone Police Court, on 29th ult., the Metropolitan Electric Supply Company, Limited, were summoned before Mr. Plowden, at the instance of the Marylebone Board of Guardians and the Marylebone Vestry, for on December 7th, 9th, 11th, 12th, and 14th, 1899, having made default in the supply of electric energy to the workhouse and the vestry premises. In a report in the daily press, we read that Mr. Muir, for the company, said he must admit the default, which, of course, was a plea of guilty. He hoped, however, to show that the company had done all that human foresight could devise to prevent the breach, which was an accident, and that as to the future measures had been taken by which, humanly speaking, it would be impossible for this cause of complaint to recur. The company, which was the oldest of its kind, was started in 1888, and commenced to supply the public with electricity in the following year. That the demands made upon them had exceeded their most sanguine expectations would be seen when he stated that whereas the number of lamps supplied in 1892 was 78,000, in 1897 it had increased to 187,000, so that in five years the supply had more than doubled. Acting under experienced advice, the company laid down engine power to the extent of hundreds of horse-power, and it afterwards turned out that it should have been thousands of horse-power. In the February of 1898 a site was secured in Willesden on which to build a generating station so as to be able to increase the supply. Contracts were entered into for the erection of works on a scale unprecedented on the Continent of Europe. But unfortunately difficulties cropped up in connection with the execution of the works, and from various causes the time limits in various contracts were broken. Owing to these delays the defendant company went to another electric supply company and got some assistance in the matter of electric energy, but that soon failed, as the company borrowed from needed all the electricity produced for their own customers. When that supply was cut off the troubles of this company commenced. There was a difficulty in securing Welsh coal for the furnaces because of the Government demand for steam coal needed by transports being sent to South Africa in connection with the war. Other coal had to be used by the defendants, and that, of course, reduced the engine power. There had been an unprecedented increase since 1897 in the number of lamps, the increase being 20 per cent., or 80,000 lamps, in addition to what they had already to provide for. One of the engines at Willesden would supply 90,000 lamps, and had that been started in 1898, as contracted for, the deficiency now complained of by the parochial authorities and by other consumers would not have occurred. To show the provision the company had made counsel stated that the whole of their works, apart from those at Willesden, provided for 8,500 KW., or half a million lamps. The addition by the Willesden works would be an increase of over 50 per cent. on the existing supply, and as the increased demand in 1899 was only 20 per cent, provision had been made for two and a half times more than was required. In consequence of the high pressure at which their works at Manchester Square were carried on in order to keep faith with the public, damage was done which necessitated the stoppage of the works for repairs for at least a week, and it was during that period that their customers made so many complaints. The first engine began to work at Willesden on November 11th, and a month later it had to be stopped for the setting right of defects commonly experienced in new machinery. Since then a second engine had been started, and in the course of 10 days a third one would be ready, and the three engines would provide a supply for 270,000 lamps. It was, therefore, evident that there would be an abundant supply in the future. He added that other works were contemplated at Willesden which would bring the supply there up to sufficient for 260,000 lamps. The company desired to acknowledge the forbearance and courtesy received from their customers during this trying period. The object of this prosecution being to ensure the fulfilment of the complainant's contract, he hoped, after the statement he had made, that the magistrate would not inflict any penalty at this period, but adjourn the summons for a period until after the dark days had passed. If no more stoppages took place he hoped the penalties would be minimised to the last degree, but if there should be several stoppages, which he did not anticipate, then of course his worship would inflict a heavy penalty. He assured the magistrate

that the deficiencies had not happened as the result of any niggardly or cheeseparing policy on the part of the company in order to increase dividends. The St. Pancras Vestry controlled their own electric lighting, and they had experienced similar difficulties to this company.

Mr. Plowden having referred to the lucid and interesting, although somewhat pathetic statement made by counsel, said it seemed clear that the company never contemplated, when it started, its future greatness, and when that fact became clear it made frantic and praiseworthy efforts to meet the emergency, efforts which had not been a complete success. As Mr. Manisty, representing the prosecution, had agreed to the suggestions made by Mr. Muir, the summons would be adjourned for three months. Mr. Plowden added that the statement made by Mr. Muir would be very gratifying to many people outside the court.

**The South Wales Electric Power Scheme.**—A Bill for incorporating and conferring powers on the South Wales Electrical Power Distribution Company, already mentioned in the ELECTRICAL REVIEW, has been duly deposited for next session. The promoters are Sir W. T. Lewis, Sir J. Gunn, and Messrs. E. P. Martin, R. Forrest, A. Hood, A. T. Walker, A. Keen, E. Ruffer, E. W. Richards, T. F. Brown, F. L. Davis, T. Webb, R. Jones, Mark Robinson, J. Cory, P. Morrel. H. Radcliffe, L. Wood, J. H. Simpson, G. F Insole, and W. H. Lewis. The capital of the company is to be £750,000, divided into 75,000 shares of £10 each, but with the right to divide these shares into "preferred half shares" and "deferred half shares." Upon this capital it is proposed to raise a further £250,000 by the creation of debenture stock, but it is expressly provided that no compulsory powers shall be put in force until at least £100,000 of the share capital shall have been subscribed. The number of directors is not to be less than five nor more than ten, and the first will be Sir W. T. Lewis and Messrs. E. P. Martin, R. Forrest, A. Hood, A. T. Walker, A. Keen, E. W. Richards, T. F. Brown, and two others. The proposed area of supply is to be the whole of the county of Glamorgan and so much of the county of Monmouth as lies between "the county of Glamorgan and the River Usk to the west of that river, including the whole of the county boroughs of Cardiff, Swansea, and Newport, part of which last-mentioned borough is east of the River Usk, and all cities, boroughs, county boroughs, urban and rural district councils, parish councils, and other parishes, townships, and places situated within such area." It is, however, enacted that the company shall not supply electricity, except to wholesale consumers, within the district of any local authority already authorised by provisional order or Act of Parliament to provide such supply, unless with the written consent of any such local authority. Clause 35 provides that "nothing in this Act contained shall confer, or be construed to confer, upon the company, the exclusive right to supply energy within the area of supply." The profits of the undertaking in any year are not to exceed 10 per cent., but this dividend is to be regulated by a sliding-scale, for which purpose the standard price to be charged by the company is fixed at 2½d. per unit. For every one-twentieth of a penny per unit charged below this price the company is to be entitled to increase its fixed dividend by 5s. The Bill provides, says the *Western Mail*, for the erection of three generating or power stations. The first will be erected in the parish of Llantwit Vardre, on an area of 19 acres between the River Taff and the Taff Vale Railway (Cardiff to Pontypridd.) The second area will occupy an area of 5½ acres in the parish of Panteg, between the Great Western (Taff Vale and Aberdare Extension Line) and the Great Western (Monmouthshire) Railway (Eastern Valleys Section.) The third station will be erected in Neath, on an area of 8½ acres between the Rhondda and Swansea Bay Railway and the Neath Canal.

**Trade Announcements.**—The Imperial Electrical Engineering and Stamping Company, Limited, has appointed Mr. J. Gutmann, of 25, Lansdowne Road, Dalston, N., its sole London representative.

We note that Mr. Bernard P. Scattergood, late head of the electrical testing department of Messrs. John Fowler & Co. (Leeds), Limited, Leeds, and Mr. Claude Johnson, jun., late of Messrs. Johnson & Phillips, Charlton, S.E., have entered into partnership as electrical engineers. Their offices are at Westminster Buildings, East Parade, Leeds.

Messrs. J. C. Lyell & Co. have removed their offices to new rooms at 53, Victoria Street, S.W. The stores will remain at No. 55.

## ELECTRIC LIGHTING NOTES.

**Aberdeen.**—Mr. Bell, electrical engineer, has reported to the Town Council to the effect that an additional 700-H.P. generating set should be installed at a cost of £6,325, and that a site should be obtained of sufficient area for a 10,000-H.P. plant to cope with the coming demand.

**Ayr.**—Judging from some amusing verses regarding inefficient electric lighting which have appeared in the *Ayr Observer*, we imagine that Ayr is under an unlucky star, for it is the only place that we know of where works designed by Mr. Hammond are not running satisfactorily. There is evidently a screw loose somewhere, and at a recent Council meeting a motion was discussed to call in an expert to try to put matters right; but this motion was, we think unwisely, withdrawn. Mr. Robert Hammond, the designer of the works, or any other of our leading consulting engineers, would doubtless, in a few days' investigation, succeed in putting his finger on the weak spot; but it would appear that they prefer to do things on the cheap at Ayr, and having paid an expert for designing the works, don't care to spend more money on expert advice, holding the original expert responsible for their own subsequent mismanagement.

**Basingstoke.**—The Council is considering the question of introducing the electric light at an estimated cost of £29,000.

**Bath.**—The Electric Lighting Committee has received from the Local Government Board sanction to the borrowing of a sum of £25,000 for electric lighting purposes.

**Birmingham.**—The formal transfer of the business of the Birmingham Electric Supply Company to the Corporation of Birmingham took place on the 1st inst. at the London and Midland Bank, when Mr. E. V. Hiley (deputy town clerk) and Mr. Clare (city treasurer) paid over to Mr. J. C. Vaudrey (managing director) and Mr. R. A. Pinsent (solicitor to the electric light company) a cheque for £420,000, and received in return the deed of conveyance and the assets of the company. It is now about two years since the agreement to purchase was arrived at, but it was arranged that the company should continue to carry on the business, receiving a profit of 6 per cent. for the year 1898, but handing over the profit for 1899. The accounts, which will be presented by the Electric Light Committee at an early date, will, it is understood, show that even at the high price at which it has been purchased, the concern comes into the hands of the Corporation as a paying enterprise. The company was registered in December, 1889, with a capital of £200,000 in £5 shares, all of which has been called; it took over a provisional order which had been originally obtained by Messrs. Chamberlain & Hockham. The installation was designed by and carried out under the supervision of Mr. J. C. Vaudrey, electrical engineer. The company started supplying current in April, 1891, and at the end of December carried forward a credit balance of £961. In 1892 a dividend of 3½ per cent. was paid, while in the succeeding years the dividends were —1893, 1894, 1895, 4 per cent.; 1896, 4½ per cent.; 1897, 5 per cent.; 1898, 6 per cent. The purchase price at which the company consented to sell to the Corporation was calculated on the basis of £10 10s. per share. The Corporation takes over the staff of the company, and Mr. Vaudrey becomes electrical engineer to the city.

**Bristol.**—At the New Year's Council meeting at Bristol on Monday Alderman George Pearson, the chairman of the Electrical Committee, brought up an important report from that body on the subject of forthcoming extensions of works at a cost of nearly £150,000. The Committee reported they had been considering the sum necessary to be expended in making provision for the probable increase in the demand for electricity during the next two or three years, and they found that the following capital expenditure would be required:—High and low pressure mains, feeders, meters, and connections to consumers, £60,389; foundations, building, engine room plant, and boiler plant at Avonbank (the name of the 9-acre site just secured for the extended station), £71,397; provision of additional plant at Temple Back (the existing station) £12,229—making a total of £144,015. The Committee recommended that £145,150 be borrowed, and they advised that the works be carried out and a loan procured. Mr. Pearson explained that he asked the Council only to equip a small portion of their new station. On the site just procured they proposed to erect a building about 230 feet long and 180 feet wide with one chimney serving the set of boilers. They would instal therein two large dynamos, each of 740 KW. capacity. These dynamos would be just double the size of the largest machines they now had in their works at Temple Back. Their engineer advised them that it was an economical process to enlarge their unit, larger units working more economically and more satisfactorily. The first thing was to show the Council that the growth of the undertaking was such as to justify this large outlay. They began modestly with 9,750 lamps, and they increased as follows:—By December, 1894, to 14,530; by December, 1895, to 24,046; by December, 1896, to 36,299; by December, 1897, to 46,149; by December, 1898, to 63,079; by December 22nd, 1899, to 81,196. In these figures all the connections were reduced to their equivalent in standard lamps of 8 C.P. The increase in the revenue was a mere reflection of the increase in the lamps. They began with a modest £6,452; they ended last year with a revenue of £20,132, and they estimated that the revenue of the present year would be £32,785. The Council would see, therefore, that the increase in the output of electricity, owing to the large increase in the number of lamps, had been very great, although in the face of a reduction of 15 per cent. in the charge for private lighting, and 30 per cent. in that for public lighting. The position of the station to-day was that they had plant for private lighting (apart from the public lighting) of 2,500 KW. capacity. They wanted a reserve equal to the largest piece of plant they had—400 KW. That reduced the capacity of the station from 2,500 to 2,100 KW. A station with that power was equal to an output of 70,000 lamps. They had 81,196 installed; the average number of lamps in use at the most active moment in the day was 50,200, and therefore they were justified in putting on with safety at least another 20,000 lamps with a station of their present size. That would give them, assuming things remained as they were, a maximum demand of about 62,500 lamps, and as they had a capacity of 70,000 they would have a margin of safety of 7,500 lamps still to their credit. They, therefore, thought that they might with safety go over the year ending March, 1901, but at that date their station would be worked up to the absolute limit at which it could possibly be run. They might expect the number of customers to increase somewhat on the lines of last year. The proposals the Committee now made would give an increase of power equal to an additional 60,000 lamps, and would bring their total up to 160,000 lamps. That being so, the question arose how soon must they commence to increase the plant to be ready to take up the load of the year ending 1902. They must have plant for that year ready not later than August, 1901. In the opinion of the engineer it was hopeless to

expect the works to be ready unless they commenced at once, and he was of opinion that unless they did so they would not be ready for the load of the winter of 1901-2. There was not a member of the Electrical Committee who did not believe in the work they were carrying on, and none of them doubted that its success would in the future equal if not exceed that of the past. The profits of to-day were nothing to what they would be hereafter, and their duty was to push their undertaking in every way they possibly could. (The afternoon being gloomy, the electric lights in the Council chamber were at this instant turned on, and there was some laughter and applause as Alderman Pearson recognised the readiness of the Council to help to increase the demand for current.) There was no opposition raised to the Electrical Committee's proposals, which were, without a division, agreed to.

**Chelmsford.**—The electric lighting company, after a tussle with the Town Council, has successfully established its right to lay necessary pipes for its water supply, without paying rent, or even, in the last resort, asking leave of the Council.

**Dartford.**—In reply to a communication from the West Kent Electricity Supply Company, Limited, containing an offer for the supply of electrical energy at certain specified rates, the Dartford Urban Council has informed the company that it has determined to instal its own generating station.

**Dewsbury.**—The Local Government Board has sanctioned the borrowing of £7,740 and £1,180 for the purposes of electric lighting.

**Dolgelley.**—Out of 500 replies to a circular note issued to the ratepayers, 235 were in favour of electric lighting. The matter was deferred.

**Dublin.**—The Town Council on the 28th ult. considered the report of the Electric Lighting Committee on the scheme prepared by Mr. Robert Hammond for the extension of the present lighting system, and for the erection and equipment of a large generating station at the Pigeon House Fort. The present station is loaded to its utmost capacity.

In Mr. Hammond's report provision is made for the supply of 100,000 8 C.P. lamps alight simultaneously, or 150,000 installed. The three-phase alternating current system of transmission will be employed between the Pigeon House and the distributing centre in Fleet Street, at a pressure of 5,000 volts and a frequency of 50 or 60 periods per second; the single-phase alternating current system at present in use, at 2,000 volts, will be altered to 2,400 volts, thus increasing the carrying capacity of the distributors by 50 per cent.

The present capacity of the distributing system is 1,695 KW., equal to the supply of 56,500 8 C.P. lamps in use at one time. The remainder of the power will be distributed from Fleet Street to 19 sub-stations without change in phase or pressure; the 19 feeders will be capable of coping with 126,000 8-C.P. lamps alight at once. Transformers of 2,400 KW. will be installed at the sub-stations, of which 600 KW. will be held in reserve. There will be 493 arc lamps for public lighting. On account of the exceptional solidity of the paving the cost of breaking up and making good the roads is estimated at 10s. per yard run; the total length of trench will be about 30 miles.

The capital expenditure in brief is estimated as follows:—

| | |
|---|---|
| Trunk mains, feeders, and distributors for private lighting | £103,000 |
| Public arc lighting | 40,500 |
| Works at Pigeon House | 96,000 |
| Meters and house connections | 15,000 |
| Total | £254,000 |

The high pressure cables will be laid in iron culverts, the low pressure mains in wooden troughing, in both cases filled in with bituminous compound. Condensing engines will be employed, as much as 500,000 gallons of condensing water per hour being provided for. Coal will be delivered at the wharf, and handled entirely by machinery. Water-tube boilers will be used for economy of space, with revolving chain grates. The engines will be of the low-speed type with Corliss valve gear; the alternators will probably work at low pressure, with step-up transformers, on account of the presence of salt in the air during rough weather.

Allowing for a proper reserve, the plant will be capable of supplying 95,000 lamps connected, in addition to the arc lamps. The financial results are estimated as follows:—

REVENUE.

| | |
|---|---|
| 95,000 lamps, 16 units each per annum, at 4·5d. | £28,500 |
| Meter rents | 1,000 |
| 500 arc lamps at £18 | 9,000 |
| | £38,500 |

EXPENDITURE.

| | |
|---|---|
| Private lighting 1,520,000 units } at 1·5d. | £16,531 |
| Public " 1,125,000 " } | |
| Gross profit | £21,969 |

out of which interest and sinking fund are to be provided for.

When the demand justifies the installation of an additional 1,000-KW. set, the output for private lighting may be increased by 760,000 units, raising the gross profit to £31,469.

Mr. Hammond's report was referred to a sub-committee, of which Alderman the Right Hon. J. M. Meade, LL.D., was chairman; the sub-committee having approved of the scheme, the committee recommended the Council that it be adopted, and that application be made to the Local Government Board for sanction to a loan of £254,500.

The recommendations of the committee were unanimously adopted by the Council, and immediate steps will be taken to carry them into effect.

**Durham.**—The Corporation announces in the *London Gazette* its proposal to transfer its electric lighting powers to the County of Durham Electrical Power Distribution Company.

**Germany.**—The Allgemeine Elektricitäts Gesellschaft, of Berlin, has secured a contract for the establishment of a central station in the town of Heiligenstadt.

**Glasgow.**—The consumption of electricity in this city during fog and darkness on the 27th ult. was unprecedented. Mr. W. A. Chamen, chief engineer, has stated that the number of units sent out of the different works was 46,000. On the corresponding day of last year the number was only 28,000.

**Govan.**—The following have been chosen as a short list out of 40 applicants for the two vacancies as assistant engineers for the electric lighting station:—Messrs. James M'Ewen, Glasgow; J. Grieve, Bridgeton, Glasgow; Andrew Brown, Leith; Peter Sisken, Craigton, Govan; D. Stewart, Govan; and J. M'Ilwaine, Govan.

**Great Malvern.**—At the last meeting of the Urban Council a special committee appointed to consider the question of establishing electric lighting in the town, advised the Council to adopt a scheme prepared by Mr. R. Hammond, upon which the initial outlay would be £30,000. Mr. Hammond anticipated a loss of £200 a year for three years, and a profit in the fourth year of £355, which would be increased as the demand for the light grew. There was strong opposition to the proposal. Mr. Yapp said it would seriously interfere with the gasworks, from which the Council derived £3,000 a year, and, considered as a whole, he thought the scheme would add from 1s. to 1s. 6d. to the rates. The chairman said there could be no doubt that electricity was the light of the future. It would be sure to come to the town, and he urged that the Council should not allow such a monopoly to pass into private hands. After a long discussion it was decided to convene a town's meeting, in order to ascertain the views of the ratepayers with regard to the outlay. The Board of Trade have intimated their intention to withdraw the powers given to the Council nine years ago if immediate use is not made of them.

**Greenock.**—The Public Loan Commissioners have granted the application of the Electricity Department of the Police Board for a loan of £50,000. The money, which is to be repayable in 30 years, has been lent at 3 per cent.

**Haydock.**—The District Council has deferred consideration of the terms quoted by the St. Helens Corporation for electric street lighting at Haydock.

**Henley.**—Mr. Wilkinson has presented a report to the Town Council, in which he estimates the cost of electrical plant for lighting the town at £14,000.

**Hereford.**—The Electric Lighting Committee reported to the Town Council on Tuesday last that the machinery was working very well, and there was every reason to be satisfied with the manner in which the contracts had been carried out; current was being taken equivalent to 1,654 8-candle lamps, and agreements had been signed for a supply equivalent to an estimated additional 2,500 8-candle lamps. Mr. Poulton's duties as clerk of works having ceased, it was decided that he should be engaged as the resident electrical engineer at £150 per annum. On the recommendation of the committee, an honorarium of £105 was granted to the city surveyor (Mr. John Parker), in recognition and as a mark of the Council's appreciation of the services he has rendered in connection with the electrical works.

**Ilford.**—A Local Government Board inquiry was held on 22nd ult., regarding the Council's application for powers to borrow £61,520 for electric lighting and tramway purposes. The details of the scheme were explained by Mr. W. C. C. Hawtayne, the consulting engineer, who estimated a gross annual profit of £4,237. 5½ per cent. would mean £3,230 for annual payment, which would leave £1,007 net profit. Some ratepayers who opposed the project were represented by counsel.

**India.**—The passenger trains of the South Indian Railway are to be lighted by electricity on the Stone system; the price of tender is £638 per train.

**Inverness.**—The Town Council last week adopted the specification of Mr. Craven, electrical engineer, for the lighting of Inverness by electricity, the motive power being steam. The town clerk was authorised to receive tenders for the installation, which will cost over £25,000.

**Leigh.**—Current was switched on at the new electricity supply works on Tuesday afternoon. The installation has cost over £10,000, and is on the three-wire system at a pressure of 440 volts. At present only the compulsory area under the Act (Market Street, Bradshaw Gate, Queen Street, Church Street, and Railway Road) is lit, but extensions are already projected. The charges are 7d. per unit for first hour and 2½d. per unit afterwards. A Committee of the Town Council has also under consideration the question of electric traction.

**Malton.**—The District Council has concluded an agreement with the Northern Counties' Electrical Supply Company, granting it permission to apply to the Board of Trade for an order empowering the company to establish works for the supply of electricity within the Council's district. The company also covenanted to light a "compulsory area" of the town with electricity within two years from date, at a cost of 30 per cent. less than is now being paid for gas.

**Limerick.**—Mr. Enright, who has been appointed consulting engineer by the Corporation, estimates the capital outlay required for an electric lighting system at £19,000.

**London, E.C.**—*Money* contains the following paragraph:—

The City of London Electric Lighting Company is full of fight, and between it and its opponents hard knocks are becoming the fashion. The directors have deposited a Bill which asks for the curious power to abolish the depreciation and reserve funds of the company, and to apply the funds already accumulated for these purposes in any way that "the board of directors may determine." The preamble to the Bill states that the obligations to provide them were undertaken by their predecessors, and were adopted by the company in consideration of the Commissioners of Sewers granting it the exclusive right of supplying electricity for private purposes within the City of London during a period of 21 years. Now that opposition has been fostered the directors contend that it is just and expedient in the above circumstances that the company should be relieved from the obligations so imposed on them in relation to their accounts and the setting aside of depreciation and reserve funds. What do shareholders think of it?

**Manchester.**—The Lancashire Electric Power Company is going to try once more to obtain an Act of Parliament for the supply of electricity to all Lancashire south of the Ribble. The share capital will be £3,000,000, with £1,000,000 loan capital. The company proposes to build generating stations at St. Helens and Manchester, and not to obtain rights of exclusive supply. A previous Bill was thrown out because of non-compliance with standing orders. Strong opposition to the measure will be renewed, to which end the public bodies affected will meet shortly.

**Monmouth.**—The Town Council will shortly require another turbine and an engine of 100 H.P. in addition to the extra turbine now on order, to supply the increased demand for private consumption of electric light.

**Newcastle-on-Tyne.**—London is by no means alone in its experience of overloaded electricity works, for some provincial towns are in the same boat. The *Newcastle Leader* complains that:—

The short days appear to have put much too severe a strain on the plant of one at least of the Newcastle electric lighting companies. The light which, in the late afternoon and the early evening, it has been possible to obtain from two or three incandescent lamps, has been scarcely superior to what might have been expected from so many halfpenny dips.

**Penzance.**—The Council has decided to expend £10,000 as a first instalment in connection with the proposed electric lighting of the borough.

**Pickering.**—The clerk to the Urban Council is to make inquiries as to the terms of the Newcastle-on-Tyne Electrical Supply Company for lighting the district electrically.

**Poplar.**—The Poplar District Board has resolved to oppose, by petition, the Parliamentary plans in connection with the Charing Cross and Strand Electricity Supply Company, London County Tramways (East India Dock Road), and the Whitechapel and Bow Railway. It was stated that the electric light company wished to lay mains down Bow Road with a view to reaching the City; while, with regard to the tramways and the railway, the Board merely wished to obtain a *locus standi*.

**Ramsgate.**—The Town Council has resolved to apply to the Board of Trade for a provisional order for supplying electricity within the borough.

**Rouen.**—A twelfth Niclausse boiler has just been installed at the central station of the Société Normande de l'Electricité in Rouen. The plant comprises two 500-H.P. Farcot-Brown steam dynamos, two 1,000-H.P. Carels-Thury ditto, and four 200-H.P. Willans-Alioth ditto.

**Russia.**—A central station has just been completed and put in operation in the town of Woronest. The plant, which has been supplied by Messrs. Siemens & Halske, of St. Petersburg, comprises three 105-KW. steam dynamos. A feature of the installation is that the boilers are fired by naphtha.

**Shoreditch.**—The Lighting Committee reported at a meeting of the Vestry on Tuesday that they had considered and approved the final plans submitted by Mr. Manville, showing the arrangement of the proposed new generating station. It was decided to approve the action of the committee, whose chairman (Mr. N. Moss) mentioned that a further report would shortly be brought forward in regard to the matter. The committee also stated that the question of making arrangements for a further supply of coal than could be obtained under the current contract, had been under consideration, and that they had resolved to advertise for tenders for a daily supply of not less than 20 tons of coal up to March 25th. It was decided to approve the action of the committee. The Vestry further endorsed the policy of the Housing Committee in giving instructions for the rooms in Provost Dwellings to be wired for electric lighting, all the tenants having applied for the work to be done.

**Stourbridge.**—The District Council has decided to oppose the application of the Midland Electric Corporation for Power Distribution, Limited, to obtain powers for electric lighting.

**Switzerland.**—The municipal authorities of Lausanne are putting down a reserve plant at their central station, and have just invited tenders for two 400-H.P. steam engines and five 400-H.P. alternating dynamos.

**Sydney (N.S.W.).**—The *Sydney Daily Telegraph* for November 27th says:—"Some critics may regard the employment of Major Cardew, the London electrical expert, to report upon a scheme of electric lighting for Sydney, as an unnecessary and very costly act of municipal administration. The arrangement made is that this gentleman shall be paid 1,000 guineas for a six weeks' visit to Sydney, and five guineas per day for any time beyond the period stated during which he may be detained here. No doubt there are many competent men in this and the other colonies who would undertake the duties allotted to Major Cardew for considerably less payment. The City Corporation has been so slow about moving in this matter that electric lighting has gone far beyond the experimental stage here. There are in successful operation a considerable number of large electric lighting plants established by private enterprise, while the system has been municipally adopted by several towns and cities. No undertaking of the magnitude of that contemplated by our City Council has yet, however, been entered upon, and such an installation probably involves problems of a different nature from those which have been successfully solved in so many cases. It is, therefore, wise economy to secure the best skill the world can supply, so that costly inaugural mistakes may be avoided."

**Torquay.**—The Town Council has directed the water engineer to specially watch water pipes at points most likely to be affected by electric cables being laid near thereto. In future water pipes are to be laid as far distant as possible from such cables. One speaker at the last Council meeting suggested the appointment of an expert to advise as to the probability of the current affecting the pipes. A special report by the electrical engineer, with reference to the extension of the plant, was referred to a special meeting by the Electric Lighting Committee, which adopted new regulations respecting installations. Additional connections, to the equivalent of 334 8-C.P. lamps, had been made during November. The question of lighting the incandescent lamps all night in the main streets was deferred.

**Tyneside.**—The Bill has been deposited for the Tyneside electric power scheme, started for the purpose of supplying electricity within an area comprising the city of Newcastle, the boroughs of Tynemouth, South Shields, and Jarrow, the urban districts of Willington Quay, Gosforth, Wallsend, Walker, Newburn, Benwell, and Fenham and Westslade, Blaydon, Whickham, Felling, Hebburn, and Ryton, and the rural districts of Tynemouth and South Shields. It is, however, provided that the company shall not, under the powers of this Act, afford a general supply of electricity within the city of Newcastle-on-Tyne, nor shall the powers granted to the company confer upon it the exclusive right to supply electrical energy within the area of supply. The capital required by the proposed company is £500,000 share capital and £166,666 which is intended to be raised by the issue of debenture stock. The share capital will be divided into 50,000 £10 shares with the right to subdivide these shares into "preferred half-shares" and "deferred half-shares." For the purpose of giving the supply within the area named, it is intended to erect three generating stations at Wallsend, Hebburn, and Whickham respectively.

The South Shields Council is communicating with all the local authorities concerned, suggesting a conference for deciding upon joint action regarding the scheme.

**Uxbridge.**—The Urban District Council has passed a resolution approving of an offer made by Messrs. Kincaid, Waller and Manville, on behalf of the Uxbridge and District Development Syndicate, Limited, and consenting to the application of the syndicate to the Board of Trade for a provisional order to supply electricity in the district. The price for public lighting will be 3d. per Board of Trade unit, and for private supply 7d. for the first 92 hours' use of the maximum per quarter, and 3d. afterwards. Terms of purchase after 10 years are to be settled by arbitration.

**Wellingborough.**—The District Council has come to terms with the Electrical Power Distribution Company, Limited, with regard to the lighting of the town.

**Wrexham.**—The engineer's estimate of the total cost of the electricity undertaking is £21,722 9s. 7d.

## ELECTRIC TRACTION AND MOTIVE POWER NOTES.

**Aberdeen.**—The electrically-equipped tramway opened here last week is the George Street and Woodside section of the system. The length of this route is about 2¾ miles, and although it is the only line on which electric traction has been substituted for horse haulage, Parliament is to be asked next session to give the Corporation power to work the entire system by electricity, and also to adopt it in new districts. On the portion of the route from St. Nicholas Street to Hutcheon Street the overhead wires are attached by metal rosettes fixed to the walls of the houses on both sides of the double line of rails, and from Hutcheon Street to near Powis Terrace the wires are fixed by rosettes on one side of the street and metal poles erected on the edge of the pavement on the other, this arrangement being rendered necessary in consequence of the buildings on the east side of the street being lower than on the west side. On the next section—from Powis Terrace to Kittybrewster Station—poles are placed on both sides of the route, and from this

point to the terminus the wires are attached to standards erected between the double line of rails. The motive power is supplied from the Corporation electric station in Cotton Street, where additional plant was required to provide the necessary current. Eight double-deck cars have been placed on the route. The average speed will be about eight miles an hour. The total cost of the undertaking is about £33,500. Of this amount £19,000 has been spent on relaying the permanent way, £10,000 on the electrical equipment and the cars (each car costing upwards of £500), and new rails cost £4,500. The contractors for the reconstruction of the permanent way were Messrs. John M'Adam & Sons, Aberdeen; for the overhead wires and cars, Messrs. M'Cartney & M'Elroy; and for the cables, the British Insulated Wire Company, Prescot. Mr. Bell is the borough electrical engineer.

**Blackpool.**—The Town Council on Tuesday adopted minutes of the Electric Lighting Committee, which included a resolution to borrow £6,000 for new tramcars.

**Cardiff.**—The sub-committee appointed by the Council some time ago to visit a number of towns where electric traction was in vogue, have completed their report, and some days ago it was submitted to a meeting of the Tramways Committee. Members of the Committee to-day touched upon several points in the report, but owing to its voluminous character, it was decided to postpone full consideration of it until the next ordinary meeting. Among the points discussed by the Committee was the kind of cars suitable for the routes. It was pointed out that the minimum headway required for a bridge under which electric tramcars for overhead traction carrying outside passengers could run is 15 feet 6 inches. The headway under several of the railway bridges in Cardiff is too low to permit the passage of cars of this description, and the borough engineer informed the Committee that unless some way can be found to overcome the difficulty it will necessitate the use of single-deck cars. The sub-committee were of opinion that double-deck cars were far preferable to single-deck ones, and that the roadways should, if possible, be lowered to meet the necessities of the case. It was decided to instruct the borough engineer to report on the question of bridges.

Replying to Councillor Robinson, Councillor Andrews stated that it was proposed to order about 2,300 tons of rails, which was as much as they had power to lay down at the present time.

**Colne.**—The Light Railway Commissioners have sanctioned the order of the Colne and Trawden Light Railway, made in March last. Some modifications have been made, the most important being the total exclusion of the clause enabling the Colne Corporation to borrow money for supplying electrical energy in or outside the district with the consent of the Local Government Board, which is not forthcoming.

**Dublin.**—An electric car off the line put the service out from 10 to 15 minutes on the 23rd ult.

**Germany.**—The contract for the establishment of a central power station in the town of Hemel in connection with the new electric tramways has been placed with the Nordische Electricitäts Gesellschaft of that town. The plant will comprise five 200-H.P. steam dynamos and a large battery of accumulators.

The owners of the Volldampf Colliery, near Drebkan, propose to construct an electric railway for the transport of coal from the pit to the coal store at Cottbus.

**Glasgow.**—On Monday afternoon, at Springburn, two electric tramcars collided. The results were very serious, a little girl being killed; the others injured included her father, both car conductors, and the driver of the car which was responsible for the accident, it having got beyond control due, it is believed, to "failure of the brake."

An electric car and a lorry collided on 23rd ult., the driver of the latter and his cart being injured.

**Hull.**—The electric tram service was delayed for over half an hour last week by an accident, said to be due to the conductor placing the trolley on the "up" instead of the "down" wire.

**Leeds.**—The Headingley and Chapeltown electric car service was to be started this week.

**Liverpool Overhead Railway.**—The Liverpool Overhead Railway Company have deposited a copy of their Bill to come before Parliament. It is proposed to construct two short extensions (1 mile 5 chains). The principal extension will be 4 furlongs 7 chains, extending from the company's northern extension railway to the western side of the Seaforth passenger station of the Lancashire and Yorkshire Railway. The remaining extension will terminate near the southern end of the East Quay of the Herculaneum Branch Dock. The company also propose to widen their existing railway near Pierhead Station, and for these purposes power is sought to raise £160,000 additional share and loan capital, of which £120,000 will be raised as ordinary capital.

**London.**—An estimate prepared on behalf of London County Council's tramway scheme gives £3,000,000 as the sum necessary for the purposes of the Bill, but it is not proposed to spend more than £250,000 before September 30th, 1901.

**Portsmouth.**—On New Year's morning representatives of the Council went to formally take possession of the tramway system, but the company's officials refused to part with the concern unless the carriage, hearses, mourning coaches, omnibuses, &c., and everything in the parishes of Portsmouth, Portsea, and Cosham were also taken over. This the municipal officials were not authorised to do. The tramway undertakings which the Corporation were to have taken over cover 11 miles of streets, and including sidings and double lines there are some 15 miles of tramways. The rolling stock consists of about 50 tramcars, and there are about 300 horses, while the omnibuses, hearses, mourning coaches and carriages number about 40. The wages bill totals up to £370 per week. Pending the settlement of the difference which has arisen between the vendors and the Corporation, the tramway service is being carried on by the company. It is understood that several counsel have been consulted as to the proper construction to be placed upon the Act, and unless the parties can arrive at a compromise the question will have to be determined in a court of law. The price to be paid for the property will be settled by Sir F. Bramwell, who has been appointed arbitrator.

**St. Helens (Lancs.).**—The Corporation have received an intimation from the Board of Trade that Mr. A. P. Trotter, their electrical adviser, will visit St. Helens to hold an inquiry into the application of the Corporation for sanction to borrow £25,000 for the purpose of electric traction.

**South Lancashire.**—The daily press says that several tramway companies intend, with the consent of nearly 30 municipal, urban, and rural authorities, applying to Parliament for powers to construct networks of electrical tramways, to practically cover the whole of Southern Lancashire, with a total area of about 120 miles. The cost of construction and equipment is stated to be put at not far short of 1½ million.

**South Staffordshire.**—A Bill has now been deposited on behalf of the South Staffordshire Tramways Company, under which it is proposed to confer powers upon their lessees, with the consent of the local authorities, to reconstruct and adapt the tramways, so that the same may be worked by electrical power.

**Sydney (N.S.W.).**—From a recent issue of the *Sydney Daily Telegraph* we gather that the Minister for Works (Mr. E. W. O'Sullivan) has received a supplementary report on the George Street tramway from the president of the Board of Inquiry (Prof. W. H. Warren). The report first of all sets out the matters on which the Board had to inquire, namely:—

(1) The question of design; (2) the various steps taken from time to time to complete the work in a businesslike and satisfactory manner, and the delay which has occurred in opening the line; (3) the failures which have taken place in carrying out the necessary tests.

The Board report that they "consider the design to be excellent, and it is in accordance with the best modern practice in electrical tramways." Regarding the question of delay, they say:—

We consider that the various steps taken from time to time to complete the work were not businesslike, for the reasons fully dealt with in the report, viz.:—(*a*) The early ordering of the generators, and urging the contractors to expedite delivery without at the same time making adequate arrangements for the completion of the buildings in which they were to be erected. (*b*) The letting of such a large number of contracts, thus dividing the responsibility and rendering it difficult to avoid the various contractors interfering with each other. (*c*) The primary cause of the delay in opening the line was the adoption of the complete scheme at Ultimo, which is over five times greater than that originally contemplated merely for the George and Harris Streets tramways. The alteration of the unit from 800 KW. to 850 KW., which caused six months' delay in consequence of the necessary dimensions of the larger machinery not being supplied with the tender. Until these particulars arrived from America it was impossible to proceed far with the plans and specifications for the power house. We consider, however, that in view of the rapid developments in electrical machinery, the alteration of the unit was wise, but that the time taken to send the particulars was excessive. (*c*) The delay in letting the contract for the power house buildings after the particulars referred to in (*d*) arrived from America, caused by the time occupied in the preparation of the plans and specifications, and in their consideration by the Railway Commissioners, we consider is mainly due to the system under which the work was controlled rather than to any of the individuals concerned. As a result of delay in completing certain buildings, the erection of the engines and generators could not be carried out in contract time; the generators were exposed to the weather, the roof not being covered in, thus requiring a much greater time for drying them out than would otherwise have been necessary.

Regarding the matter of the tests, the Board further reported:—

(*a*) Up to the time of sending in this report, the plant was not in a condition to warrant the application of the tests required by the specification. The engines had failed repeatedly to develop full power, owing to heating of the crank-pin bearings. Two of the engines and generators were loaded up to full power on November 8th without heating, and, as far as we could ascertain, were ready for service. (*b*) With regard to the permanent way, the feeder junction boxes have developed defects in insulation which are at present being remedied by the contractors. The design of these boxes, and the method of insulating the joints, are defective. (*c*) The switches at cross-over roads did not work smoothly during the trial trip, but these may improve with traffic. (*d*) The loop at Circular Quay can be traversed by the tramcars without difficulty. (*e*) The methods adopted in wiring behind the switchboard are not in accordance with the best practice, in view of the risks from fire. (*f*) We consider that it would not be advisable to apply the insulation tests recommended by the Railway Commissioners—namely, 2,500 volts—until the generators have been running under load for at least a month, and are thoroughly dry.

Finally, the Board reported that, although a considerable amount of work yet remained to be done at the Ultimo power house before it was completely finished, they were unable to see any reason why this work should not be in a fit condition, and the feeder junction boxes rectified so that traffic might be safely commenced by December 1st at the latest.

**Todmorden.**—Electric lighting and tram proposals will occupy the attention of the Council very shortly.

**Wellingborough.**—The British Electric Traction Company has served the Council with notice of intention to apply for an order enabling it to construct a tramway in Wellingborough and district.

## TELEGRAPH AND TELEPHONE NOTES.

**Cables in the Far East.**—The *New York Herald* publishes a despatch from Washington stating that, through the British Government, the Eastern Extension Cable Company has submitted claims for subsidies allowed in the concessions granted to it by Spain, and has protested against the laying of cables in the Philippines. The *Herald's* correspondent adds that the claim will certainly not be granted.

**The Chinese Telegraph System.**—According to advices received in St. Petersburg, *viâ* Khabarovsk, a Shanghai newspaper publishes an article, in which the union of the French Indo-Chinese telegraph lines with those of Russia in Siberia is projected. The article states, says the *Morning Post*, that China is joined to Russia by three, and will soon be joined to her by four, Continental telegraph lines, the tariff of which is considerably lower than that of sea cables. If the Indo-Chinese lines were connected with the nearest Russian telegraph station, the question of Continental telegraphy would be solved. Official French telegrams could then be transmitted to Russia *viâ* China. France could obtain the right, by negotiations with China and Russia, to have her own wire included in the Chinese system. The article concludes by saying that the undertaking could be carried out by the French Administration, or by a contractor, with the support of the Government.

**The Pacific Cable Question.**—The *Toronto Globe* has drawn attention to the inexplicable delay in the matter of the Pacific cable. It is nearly six months since the British people were told that the Home Government had reversed its attitude, had thrown overboard the Eastern Extension monopoly, and had undertaken with Canada and the Australian Colonies to put the cable through without further difficulty. It is time to inquire what has been done since then. Is the cable being manufactured, and where? When will the actual laying of the cable commence? When will Canada be able to communicate freely every hour of the day with Australia and New Zealand over an all-British wire? Has anything whatever been done since last midsummer, or will anything more be heard of it for another six months? These are all questions in which the public are interested, and they demand answers. When Mr. Mulock brought the matter before Parliament last session, and obtained all the powers the Government asked, the country was led to understand that all difficulties were at an end. Parliament was a unit in favour of the cable, and in the satisfaction felt that at last it was to be laid. What now blocks the way? Verily this masterly inactivity and delay is amazing, but it may have its serious side if carried too far. It may, indeed, be discovered, when too late, to be unwise, and worse, to trifle with the whole Colonial people in the interests of a huge and influential monopoly in London.

**Landline Communication with China.**—A St. Petersburg correspondent of the *Globe* telegraphs as follows:—"The telegraph line between Kiakhta and Peking is completed." In one line of six words the Russian journals announce the establishment of direct telegraphic communication between Russian territory and Peking. The progress of the work has been kept secret, as may be judged by the fact that on December 11th it was announced here that this line would be in full working order in a few months.

**Reduction of Rates to Australia.**—The South Australian Government has accepted the following proposals by the Eastern Extension Telegraph Company:—

1. To at once reduce the telegraph rates to the whole of Australia, including Tasmania, to a uniform tariff of 4s. per word on private or ordinary messages, 3s. per word on Government messages, and 1s. 6d. per word on press messages, subject to further reductions explained in telegrams from Mr. Hesse.
2. To lay a cable from South Africa (Durban), *viâ* Mauritius, Rodrigues, and Cocos Islands, to Fremantle and Glenelg.

The Government will also lower international charges in South Australia from 7d., 5d., and 4d., to 5d., 4d., and 3d. per word for private, Government, and press messages respectively.

The company agrees to make step by step reductions on the following basis:—

1. If the associated companies' receipts from the Australasian traffic in 1898, 1899, and 1900 are maintained, the rate to be reduced to 3s. 6d. in 1901. 2. If the average receipts maintain £350,000 in 1899, 1900, and 1901, the charge on the messages to be reduced in 1902 to 3s. 3. If the average receipts are maintained at £350,000 in 1900, 1901, and 1902, the charge to be still further reduced in 1903 to 2s. 6d. 4. Should the average receipts not keep up to £350,000, any one of the above reductions would be postponed until the receipts average the standard figure of £350,000 for three consecutive years.

In New South Wales it appears, however, that the Government do not propose, without examination, to hand over control of international telegrams to the company which has hitherto had the matter entirely in its hands. We read that the Premier, replying in the Assembly to Mr. Suttor, who asked, without notice, if the Government had come to any decision upon the proposal made by the Eastern Extension Company to lay a cable from the Cape to these colonies, said it had been to a very large extent dealt with by the Postmaster-General. A telegram had been received that would require further consideration. Mr. Cann wished to know if, before completing negotiations, the Premier would give the House an opportunity of saying whether the cable company should be allowed to deliver its own messages. Mr. Lyne said at the present moment he did not know what was underlying the question. He did not want to make a promise that, after maturer consideration, he might regret having made. He hoped the matter would be thoroughly thrashed out.

**Reserved Telegraphists in South Africa.**—A correspondent (J. L. du Plat Taylor) of the *Times* writes to say that his old regiment, the Post Office Volunteers, is furnishing to the forces in South Africa a contingent of skilled telegraphists, who are embodied in the Telegraph Battalion Royal Engineers. This corps, known as the "Corps of Reserved Telegraphists," 100 strong, is recruited from the efficient members of the telegraph companies of the Post Office Volunteers. They enlist in the Royal Engineers, and, in peace time, are at once transferred to the Reserve. As soldiers in the Telegraph Battalion Royal Engineers the members of the corps have already twice served in campaigns in Egypt—Nile and Suakin—to the satisfaction of the officers under whom they served.

### Telegraphic Interruptions and Repairs:—

| Cables. | Down. | Repaired. |
|---|---|---|
| West Indies:— | | |
| Jamaica-Colon ... ... ... | June 30, 1899 ... | ... |
| Trinidad-Demerara (1891 duplicate) ... ... ... ... | Oct. 23, 1899 ... | ... |
| South African:— | | |
| Zanzibar-Mombasa ... ... | Oct. 26, 1899 ... | ... |
| Mozambique-Lourenço-Marques | Dec. 17, 1899 ... | ... |
| Cayenne-Pinheiro ... ... ... | Oct. 11, 1899 ... | ... |
| Latakia-Cyprus ... ... ... | June 20, 1899 ... | ... |
| Gibraltar-Tangier ... ... ... | Jan. 1, 1900 ... | ... |
| Tarifa-Tangier ... ... ... | Jan. 3, 1900 ... | ... |
| **Landlines.** | | |
| West Indies:— | | |
| Communication with Les Cayes (Haiti) ... ... ... ... | Nov. 21, 1899 ... | ... |
| South African:— | | |
| Communication with Mafeking and beyond ... ... ... | Oct. 13, 1899 ... | ... |
| Communication with all offices beyond Orange River ... ... | Oct. 18, 1899 ... | ... |
| Communication with north of Mooi River (Natal) ... ... | Oct. 22, 1899 ... | ... |
| Colombian Government lines to Bogota ... ... ... ... | Oct. 21, 1899 ... | ... |
| Communication with Colombia ... | Nov. 6, 1899 ... | ... |
| Communication with Valentia (Venezuela) ... ... ... | Nov. 18, 1899 ... | ... |

**Telegrams to St. Helena and Ascension.**—Tuesday's *Gazette* contains the following notice:—"Telegraphic communication having been established with St. Helena and Ascension *viâ* Cape Town, the following rate is chargeable:—St. Helena or Ascension (Eastern Company, Direct Spanish Company, *viâ* France), 7s. per word."

**Wireless Telegraphy.**—The *Times* correspondent at Modder River sends some further news regarding the wireless telegraph apparatus. His communication is dated December 23rd:—"Experiments made with wireless telegraphy have shown that the excessive dryness of the air and the soil here, and the slight impediments in the latter, cause obstructions in the earth current. The difficulty has been partially overcome by attaching the wire to the railway or to a wire fence, thus increasing the area of contact, or by using zinc troughs filled with wet earth. The fall of rain, which is now overdue, will facilitate the working. The Boer plant confiscated was made by Siemens & Halske, not by Signor Marconi."

## CONTRACTS OPEN.

**Aberdeen.**—January 22nd. The Electric Lighting Committee wants tenders for a 420-kw. direct coupled continuous current dynamo. See "Official Notices" to-day.

**Accrington.**—January 10th. The Town Hall Committee invites tenders for the switchboards, wiring and other works and appliances necessary for the electric light installation in the Town Hall. For specification, and to view the various rooms, apply to the Borough Surveyor, Town Hall.

**Barking.**—January 23rd. The Urban District Council wants tenders for two continuous current transformers and switchgear, underground cables and roadworks for the Creeksmouth electric lighting extension. See "Official Notices" December 29th.

**Barnes.**—January 9th. The Urban District Council is inviting tenders for the supply and erection of:—(Section A) boilers; (B) steam dynamos and switchboard; (C) storage batteries; (D) cables, &c. Only those firms with plant of a similar size and type working satisfactorily in other electricity works will be allowed to tender. Specifications, &c., of the Surveyor, Council Offices, High

Street, Mortlake, on deposit of £1 1s. for each section. Plans, specifications, &c., may be inspected at the offices of the engineer, Mr. William Fairley, 53, Victoria Street, S.W.

**Beira.** — The Companhia de Mocambique is inviting tenders for laying down plant for electrically lighting the town of Beira (Portuguese East Africa) and for working same for 25 years. See "Official Notices" this week.

**Belfast.**—February 8th. The Electric Committee wants tenders for 400-KW. steam dynamos. See our "Official Notices" to-day.

**Bermondsey.**—January 13th. The Vestry wants tenders for the construction, &c., of a dust destructor, with furnaces, water-tube boilers, economiser, fans and forced draught appliances, in connection with the electricity supply undertaking. See "Official Notices" December 15th.

**Birkenhead.**—January 16th. The Corporation is inviting tenders for the construction of a new electricity generating station in connection with the electric tramways.

**Ilford.**—January 20th. The District Council wants tenders for water-tube boilers, economiser, pumps, pipe work, two 200-kw. and one 100-kw. dynamos, motor boosters, battery, switchboard, 15-ton traveller, mains and road work, arc lamps and posts, and station lighting. See "Official Notices" December 15th.

**Melbourne.**—March 1st. The Corporation is wanting tenders for boilers, engines, dynamos, switchboard, feeders, mains, arc light leads, accumulators, &c., for electric lighting. See "Official Notices" December 22nd.

**Newcastle-on-Tyne.**—January 24th. The Corporation wants tenders for laying down about 11 miles of double line tramway, the rails, fastenings, and the poles being supplied by the Corporation. See "Official Notices" December 22nd.

**Plymouth.** — January 31st. The Corporation wants tenders for a 500-KW. steam dynamo (motor generators, &c.); a 500-KW. steam alternator, &c.; accumulators; Lancashire boilers and equipment; mains. See "Official Notices" to-day.

**Salford.**—January 8th. The School Board invites tenders for the electric lighting of the new schools in Grecian Street North, Lower Broughton. See "Official Notices" December 22nd.

**Sheffield.**—January 20th. The Electric Lighting Committee invites tenders for steam and exhaust pipes and jet condenser for the electricity works. See "Official Notices" to-day.

**Spain.**—January 16th. Tenders are being invited until January 16th by the municipal authorities of Utrera for the concession for the electric lighting of the town by means of 300 10-C.P. lamps and 100 16-C.P. lamps. Tenders to be sent to El Secretario del Ayuntamiento de Utrera (Spain) whence particulars may be obtained.

**Tunbridge Wells.**—January 15th. The Corporation invites tenders for condensing plant to deal with 30,000 lbs. of steam per hour. See "Official Notices" December 22nd.

**Tunbridge Wells.**— January 25th. The Corporation wants tenders for a 400-KW. steam alternator. See "Official Notices" to-day.

**Tynemouth.** — Tenders are wanted for free wiring of premises in connection with the Corporation electricity works. See "Official Notices" December 29th.

## FORTHCOMING EVENTS.

Tuesday, January 9th.—At 8 p.m. The Institution of Civil Engineers Papers:—"The Purification of Water after its use in Manufactories," by Reginald A. Tatton, M.Inst.C.E.; "Experiments on the Purification of Waste Water from Factories," by W. O. E. Meade-King, M.Inst.C.E.

Thursday, January 11th.—The Institution of Electrical Engineers, Report of the Institution's visit to Switzerland. The report will be taken as read, and the discussion will be opened by Mr. Crompton, by "A Comparison between British and Continental practice in Electrical Engineering."

Friday, January 12th.—At 8 p.m. Institution of Civil Engineers, Students' meeting. Address by Prof. T. Claxton Fidler. M.Inst.C.E., on "The Theory of Structures and Strength of Materials."

## A NOTE ON THE ELECTRICAL RESISTIVITY OF ELECTROLYTIC NICKEL.*

By J. A. FLEMING, M.A., D.Sc., F.R.S.
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THE numerical values assigned by various experimentalists for the mass or volume electrical resistivity of certain metals differ very considerably. Some metals are without much difficulty prepared as often as required in a state of such chemical purity, and brought so easily into similar physical conditions as to annealing and density, that determinations made by different observers of their resistivity or specific electrical resistance are nearly identical.

Matthiessen's long-accepted value† for the mass resistivity of copper in the form of hard-drawn wire, viz., 0·14493 standard ohm per metre-gramme, was substantially confirmed by the more recent work of Mr. T. C. Fitzpatrick.‡ Even the purest electrolytic copper now obtainable in an annealed condition does not show an electric conductivity more than 3 per cent. greater than that of a similar character prepared 35 years ago by Matthiessen.

In a research carried out in the years 1892 and 1893 by the author in conjunction with Prof. Dewar, careful redeterminations were made of the volume-resistivity at 0°C. of all ordinary metals, taken for the most part in an annealed condition and in a state of great chemical purity.

The values so obtained for the electrical volume-resistivity of silver, copper, gold, aluminium, zinc, platinum, tin, lead, magnesium, and iron agreed fairly well with the values given by Matthiessen, and quoted in most of the treatises on electricity. The resistivity of cadmium, as given by us, was, however, considerably larger than that usually stated, although our sample of cadmium was very carefully prepared.

In the case of nickel, the purest nickel we were able to obtain was that prepared from nickel-carbonyl. Dr. Ludwig Mond, F.R.S., was so kind as to furnish us with two tubes of this nickel. It was found, however, to be too brittle to draw into wire, and the operation of melting it would have most certainly introduced impurities. Accordingly the nickel tube was cut up in the lathe into a spiral, and a resistance coil formed with it, which could be used for taking the resistivity ratios at different temperatures, but which was not sufficiently uniform in dimensions to permit its volume-resistivity to be calculated. Hence, in our published results, we took the volume-resistivity of this nickel at 0° C. to be 12,320 C.G.S. units, which is the value given by Everett, said to be derived from Matthiessen's experiments, and simply calculated the resistivity at other temperatures from the experiments given by our own observations with the Mond nickel. About a year ago, however, Mr. J. W. Swan, F.R.S., sent me a sample of nickel wire which he had prepared electrolytically from a hot solution of very carefully purified nickelous chloride. The electrolytic metal was annealed by heating in an atmosphere of hydrogen, after having been drawn into wire through a die.

The nickel wire so prepared and annealed is as soft as a silver wire. It had a fairly uniform diameter of about 0·01 inch, and a length of nearly 250 cm.

The mean diameter of this wire was taken with the micrometer microscope at regular intervals of 5 centimetres with the following results:—

DIAMETRAL MEASUREMENTS OF NICKEL WIRE, AS READ BY MICROSCOPE AT REGULAR INTERVALS OF ABOUT 5 CM.

| Obs. | Diameter (inches.) | Obs. | Diameter (inches.) |
|---|---|---|---|
| 1 | 0·0097 | 26 | 0·0100 |
| 2 | 0 0097 | 27 | 0 0096 |
| 3 | 0 00975 | 28 | 0·0098 |
| 4 | 0·0107 | 29 | 0·0093 |
| 5 | 0 0100 | 30 | 0 0099 |
| 6 | 0 0098 | 31 | 0 0102 |
| 7 | 0 0100 | 32 | 0·0098 |
| 8 | 0·01015 | 33 | 0·00975 |
| 9 | 0·01015 | 34 | 0·0095 |
| 10 | 0 0100 | 35 | 0·0098 |
| 11 | 0 0098 | 36 | 0·00985 |
| 12 | 0 0100 | 37 | 0·00965 |
| 13 | 0 01015 | 38 | 0·0098 |
| 14 | 0·0099 | 39 | 0 00985 |
| 15 | 0 0101 | 40 | 0 0101 |
| 16 | 0 0099 | 41 | 0 0096 |
| 17 | 0·0099 | 42 | 0·0094 |
| 18 | 0 01005 | 43 | 0 0098 |
| 19 | 0 0097 | 44 | 0·0098 |
| 20 | 0 0098 | 45 | 0 00995 |
| 21 | 0 0098 | 46 | 0 0098 |
| 22 | 0 00985 | 47 | 0 0098 |
| 23 | 0 0101 | 48 | 0 0096 |
| 24 | 0 0100 | 49 | 0 0099 |
| 25 | 0·01005 | 50 | 0·0101 |

* Read before the Royal Society on December 14th, 1899.
† See "B.A. Report," 1864, or *Phil. Mag*, 1865.
‡ See "B.A. Report," Leeds, 1890, or ELECTRICAL REVIEW, Vol. 27, p. 357, 1890.

The mean diameter of the wire, as obtained from the above 50 readings, was 0·00985 inch. This was checked by taking the density of the wire with all the usual precautions for obtaining a correct value.

The length, weight in air, and weight in water were determined to be as follows:—

| | |
|---|---|
| Length of the wire... ... ... ... | 246·98 cm. |
| Weight in air ... ... ... ... | 1·1163 grammes. |
| Weight in water at 18° C + suspension | 1·00175 „ |
| Weight of suspension ... ... ... | 0·1000 „ |
| Weight of wire at 18° C. in water ... | 0·99175 „ |

From the above observations the density was found to be 8·96 at 18° C. The mean diameter calculated from the length and density is then 0·00997 inch. Hence we have:—

| | |
|---|---|
| Mean diameter from micrometer measurement ... | 0·00985 inch. |
| Mean diameter by specific gravity and length measurement ... ... ... ... ... | 0·00997 „ |

The mean of both means is 0·00991 inch = 0·02567 cm. This last number was taken as the value of the mean diameter.

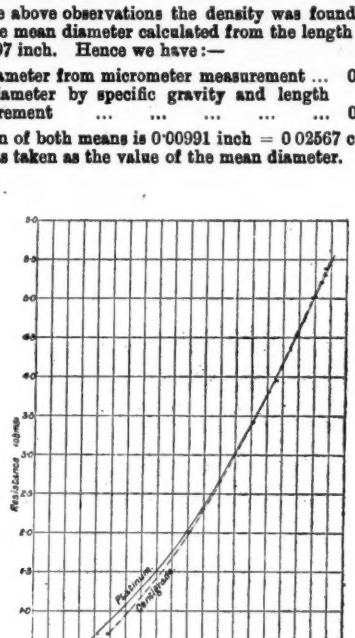


Fig. 1.—Temperature Resistance Curve for Electrolytic Nickel Wire.

The nickel wire was then soldered to thick copper leading-in wires, and wound on a frame of a kind suitable for immersion in liquid air.

A description of this particular kind of resistance coil, which has proved itself to be exceedingly suitable for low temperature work, was given in a paper describing the result of numerous observations on the resistivity of metals at low temperatures, published by Prof. Dewar and the present author in 1893.*

A coil having been thus constructed, its resistance was taken at various temperatures in a bath of paraffin oil, and the results are as shown in the table below. The temperature of the bath was measured at the same time by means of a platinum thermometer ($P_1$) used in previous researches.

The conversion of the platinum temperatures into centigrade temperatures was effected by means of a table drawn up by Mr. J. Hamilton Dickson † for this thermometer.

The measurement of the resistance at low temperatures (−78·2° and −182·5°) was obtained by measuring the coil in liquid air and melting $CO_2$ at the Royal Institution Laboratories, by kind permission of Prof. Dewar.

Observations on the Resistance of Electrolytic Nickel Wire.

| Obs. | Total resistance of nickel wire. | Platinum temperature, *pt.* | Centigrade temperature C. | Volume resistivity in C.G.S. units. |
|---|---|---|---|---|
| 1 | 3·4284 | 1·057 | 1·232 | 6,974 |
| 2 | 3·7563 | 18·489 | 18·29 | 7,641 |
| 3 | 3·9470 | 28·676 | 28·32 | 8,029 |
| 4 | 4·1109 | 36·959 | 36·51 | 8,363 |
| 5 | 4·3506 | 48·740 | 48·21 | 8,850 |
| 6 | 4·5679 | 58·773 | 58·23 | 9,292 |
| 7 | 4·5778 | 59·315 | 58·78 | 9,312 |
| 8 | 4·7493 | 67·384 | 66·85 | 9,661 |
| 9 | 5·0403 | 80·550 | 80·11 | 10,253 |
| 10 | 5·2018 | 88·587 | 88·25 | 10,582 |
| 11 | 5·3600 | 93·544 | 93·29 | 10,782 |
| 12 | 5·3882 | 95·731 | 94·88 | 10,961 |
| 13 | 5·2379 | 89·289 | 88·97 | 10,655 |
| 14 | 5·0094 | 78·482 | 78·02 | 10,190 |
| 15 | 4·7273 | 66·700 | 66·17 | 9,616 |
| 16 | 4·5260 | 57·151 | 56·61 | 9,207 |
| 17 | 4·3586 | 48·704 | 48·18 | 8,865 |
| 18 | 4·1323 | 37·906 | 37·44 | 8,406 |
| 19 | 3·9620 | 31·226 | 30·83 | 8,060 |
| 20 | 3·8112 | 21·550 | 21·30 | 7,753 |
| 21 | 3·4318 | 2·205 | 2·35 | 6,981 |
| 22 | 2·090 | −80·72 | −78·2 | 4,251 |
| 23 | 0·710 | −196·89 | −182·5 | 1,444 |

The total resistance of the nickel calculated from the above observations is set out in the form of a curve (fig. 1), having resistance as ordinates and temperature as abscissæ.

The curves are given both for temperature in centigrade degrees and temperature in platinum degrees. The curve shows that the resistance is falling steadily downwards to a zero value as the absolute zero of temperature is approached.

In fig. 2 the portion of the curve between 0° C. and 100° C. is shown on an enlarged scale. In fig. 3 the volume resistivity is set out in terms of temperature.

The results show that the volume resistivity or resistance per centimetre cube of this electrolytic nickel at 0° C. is 6,935 C.G.S. units.

The average temperature coefficient between 0° C. and 100° C. is 0·00618.

The above observations indicate that this electrolytic nickel, as prepared by Mr. Swan, has an exceedingly different and much lower resistivity than that employed for test by Matthiessen 35 years ago.

The value of the mean temperature-coefficient of the nickel used in the experiments of Fleming and Dewar in 1893, and prepared by Dr. Ludwig Mond, was 0·00622 * between 0° C. and 100° C. It is clear, therefore, that some extraordinary electrical difference exists between nickel as it can now be produced electrolytically, and nickel as it was produced by Matthiessen for his experiments.

It would be interesting to ascertain if any specimen of nickel known to have been used by Matthiessen for his experiments still exists, and if so, to discover the nature of the impurity (if impurity was present), or at least the physical difference, which caused his nickel to have nearly double the electrical resistivity of that which can now be produced.

I desire to record my thanks to Mr. J. E. Petavel and to Mr. A. Blok for assistance in these experiments.

*Note added December 6th*, 1899.—Since writing the above short paper, I have discovered in a paper by Messrs. A. Matthiessen and C. Vogt,† a reference to the sample of nickel with which the present accepted figure for its resistivity was evidently obtained.

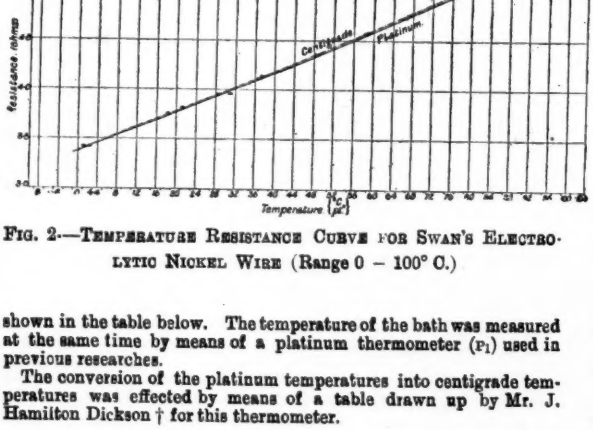


Fig. 2.—Temperature Resistance Curve for Swan's Electrolytic Nickel Wire (Range 0 − 100° C.)

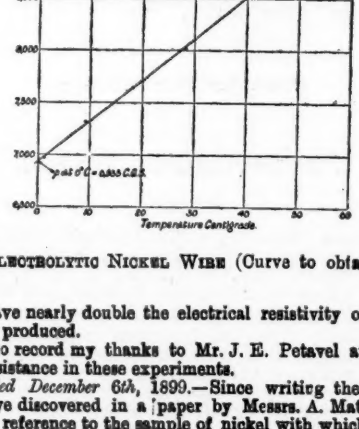


Fig. 3.—Electrolytic Nickel Wire (Curve to obtain $\rho$ at 0° C.)

* See *Phil. Mag*, September, 1893, p. 279, "On the Resistance of Metals and Alloys at Temperatures approaching the Absolute Zero."

† *Phil. Mag*, June, 1898.

* *Phil. Mag*, September, 1893.

† *Phil. Trans. Roy. Soc.*, 1863, p. 384.

This paper is entitled "On the Influence of Temperature on the Electric Conducting Power of Iron and Thallium," and its title would not lead a reader to look in it for a reference to the resistivity of nickel.

Messrs. Matthiessen and Vogt therein state that samples of supposed chemically pure nickel and cobalt wires prepared by M. Deville were given to them by M. Wöhler. They measured the resistivity of these samples, but they state that their electrical behaviour gave them reason to believe that this nickel and cobalt were not pure. They give the electrical conductivity of the nickel as 13·11 at 0° C., taking hard drawn silver at 0° C. as 100.

Hence if hard drawn silver has a volume resistivity of 1,620 C.G.S. units at 0° C., it follows that Matthiessen and Vogt's value for the resistivity of their sample of nickel would be 12,357 C.G.S. units at 0° C., which is a number very close to that usually given in tables of electrical specific resistance.*

Matthiessen and Vogt state in this paper that they hope to be able to prepare pure nickel electrolytically, and obtain a value for its electrical resistivity. I have been unable to discover, however, that they ever carried out their intention. At any rate, the number which they give for the electrical volume resistivity of this nickel of the purity of which they evidently had suspicions, has been accepted for the last 36 years as the true value.

## NOTES.

**The Resistance Offered by Iron Wires to Alternating Currents.**—A paper under this title is contributed to the *Physical Review* by Mr. Ernest Merritt. As a matter of fact, his principal observations are not of resistance, but of impedance, and their exact bearing is obscured by the false description. The conduction of an alternating current by an iron wire is an interesting and important case of conduction in a highly inductive circuit, and has, of course, an immediate practical bearing on telegraphy and telephony. It is particularly interesting to observe in Mr. Merritt's diagrams that the difference between the resistance and the impedance varies with the intensity of the current and the corresponding permeability of the iron, very much as would be predicted from general considerations of the ordinary magnetisation curves.

**200-Volt Supply.**—A letter in the *Times* from "Consumer," who referred to the alteration by electric lighting undertakers of the standard pressure of supply from 100 to 200 volts, is replied to in a second letter, signed "M.I.E.E." :—

Supposing £200,000 represented the amount expended in mains by undertakers supplying at 100 volts; a change to 200 volts would make it possible to connect about four times as many lamps to those mains, with a saving of about £600,000. This serves to illustrate the immense value to the undertakers of the right to change the pressure. A local authority, in giving its consent to such a change, may make the condition that the necessary changes in consumers' lamps, wires, and fittings shall be done at the expense of the undertakers. Where there is genuine competition in a district, the interests of consumers as regards the price of the supply will probably be sufficiently secured. But where there is no such competition or no competition at all, a local authority, being in favour of the change of pressure because of its desire to reduce the inconvenience caused by laying mains, naturally would seek to secure to the consumer a fair proportion of the advantages which the undertakers gain by the change. The position of such a local authority is that it is completely in the hands of the undertakers, and has no power to impose any conditions on the undertakers for a reduction in the price of the supply. Here is the weakness of the whole situation, from the consumers' point of view. In the end it cannot be to the general good that the undertakers should spend needless hundreds of thousands on mains, and in London interference with the public ways ought to be reduced to a minimum. Nevertheless, it is not fair that the undertakers should have all the pecuniary benefit of using the higher pressure while consumers are at a disadvantage, though not at such a disadvantage as "Consumer" would make out. Local authorities should combine to obtain the necessary powers to deal with this matter in a fair and sensible manner.

* The numerical values of the specific resistance of nickel given in various tables by different authors are not quite identical, and yet all so far found are stated to be derived from Matthiessen's experiments. Thus, Everett ("C.G.S. System of Units," 1891 ed.) gives 12,320 C.G.S. units at 0° C. as the value. Landolt and Börnstein give one value equivalent to 12,757 at 0° C. from the ratio of conductivity of nickel to that of mercury, and another equivalent to 12,014 at 0° C., derived from the ratio of the conductivity of hard drawn silver to that of nickel.

**An Electrical Fire.**—In our issue of December 22nd we referred to the electrical fire described by Mr. Montagu Crackanthorpe, Q.C., in the "Correspondence" columns of the *Times*. This letter coming on the top of other letters which were complaining about the interruption or low voltage of supply (already dealt with by us editorially) has received considerable attention in the Press, and led to quite an extended discussion in the *Times*. The breadth no less than the importance of the subject raised is shown by the signatures of the various contributors, for, starting with a Q.C., the discussion is taken up by the President of the Institution of Electrical Engineers, fire insurance inspectors, a M.I.E.E., an architect, a consumer, and others. No subject seems so fruitful of suggestion and discussion as this question of "good or bad electric wiring." Each contributor presents his pet remedy, such as: No wires between floors, lead-covered wires, non-inflammable wood casing, the prohibition of wood casing, the use of non-conducting fire and water-proof tubes, periodical testing of wires, an electrical testing department of the London County Council to examine wiring systems and make reports to ratepayers on fire possibility, a general agreement in respect to rules, employment of a consulting electrician, decrease of voltage from 200 to 100 volts—these are a few of the suggestions, each having some point of use and interest. The above offer evidence of a general unsettledness of "faith and principle," but each falls to the ground by lack of uniformity of opinion, and the main effect of the discussion is only to increase the obstinacy and dogmatism of each debater. The fact that this "wiring question" periodically forces itself to the front shows that we have in it a problem which must be of vital interest to the general development of the electrical industry, and although the tendency in the past has been to "shelve" it and await a general consensus of opinion, each recurrence of the discussion shows how acute and widespread is the interest in it. We do not go so far as one of our contemporaries, which believes that at this moment the "popularity of electric lighting is threatened," but it is evident that the time and occasion is close upon us when some effective solution of the wiring question must be found. The solution must be such as will benefit the electrical profession and public alike. "Low first cost and safety" are the chief requirements of the public, whilst "simple effective construction," "scientific utilisation of material," "permanence," and "competitive value" are the main qualities requisite for the satisfaction of the electrical trade interests. This is the question which has to be thoroughly discussed and elucidated in the present development of our knowledge and with the material at our disposal—which system of wiring best supplies or will ultimately fulfil the above-mentioned requisites. How shall this be determined and who shall settle it?

**Personal.**—Mr. C. P. Sparks, the new chief engineer to the County of London and Brush Provincial Electric Lighting Company, Limited, has been appointed consulting engineer to the Richmond (Surrey) Electric Light and Power Company, Limited.

For the post of resident engineer and clerk of works for the Huddersfield Corporation electric tramways there were 13 applicants. The Tramways Committee has recommended the appointment of Mr. H. N. Thomas, of Douglas, superintending engineer to the Isle of Man Tramways Company.

Mr. Britton, assistant engineer at the Southampton electricity works, has been appointed chief at Barking. Mr. F. R. Bridger, second assistant, takes Mr. Britton's place at Southampton, and Mr. S. L. Smith becomes second assistant.

**Electric Riveters Wanted.**—A correspondent writes to us as follows:—"Some time ago I received an inquiry for electric riveters specially suitable for bridge building. Having no experience in this kind of electric machinery, I shall be greatly indebted to you if you will kindly inform me of good reliable makers who make *electric* riveters a speciality." Perhaps some of our readers or advertisers may be able to render service to our correspondent in this matter.

**Electric Avenue, Brixton.**—The Christmas decorations of this busy thoroughfare in South London were more elaborate than in previous years. There was a large cartoon in the centre of the street; on one side, a figure of Britannia standing on African soil holding a wreath in each hand over the heads of a soldier and a sailor, with the legend underneath, "Success to Our Heroes." On the other side was the British Lion giving chase to Oom Paul. The picture was illuminated by four powerful arc lamps. The street was festooned across with evergreens, much as usual, but at intervals along the verandah there were 28 stars painted with floral designs, each lighted with three 16-C.P. incandescents. There were also 64 smaller stars each lighted by a 32-C.P. lamp, and Christmas trees on the front, lighted by various coloured 16-C.P.'s, 30 lights on each tree. Mr. Christie, the engineer-in-charge of the Avenue station, was, as usual, responsible for the transformation of the busiest of business places into a veritable fairyland, but some ill-natured critics were unpatriotic enough to suggest that the position of the Lion and Oom Paul should have been reversed. The artist was merely premature, that is all. When the good time comes for the lion and the lamb to lie down together, "I guess," said the Yankee, "it will be with the lamb inside the lion," so let Kruger take heed, lest he too should meet a like fate.

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**Lecture.**—The week before last Mr. Price, superintendent of the electricity works, lectured at Portsmouth on "Electricity: the Portsmouth Supply." The lecture was delivered under the auspices of the St. Thomas's Ward Municipal Association. Mr. Alderman Ellis followed with some remarks regarding the policy of the Tramways Committee in adopting a separate station instead of taking current from the lighting station. That policy, he said, was a wrong one.

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**Finsbury Technical College.**—The College classes re-open on Monday, January 8th. There will be lectures on Monday nights on "Continuous Current Machines" and "Arc Lamps;" and on Wednesday nights on "Design of Electro-magnets." There is to be a special course of lectures by Dr. Dvorkowitz in February and March on "Petroleum."

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**E.M.F. of the Clark Cell.**—We referred some time ago to a determination by Paterson and Guthe of the electro-chemical equivalent of silver by means of a new electro-dynamometer of refined construction. The result of this determination was 0·0011192 gm. per ampere, per sec., as against Glazebrook and Skinner's value, 0·001118. Messrs. Carhart and Guthe have now used the same electro-dynamometer to determine in absolute measure the electro-motive force of the Clark cell, and have obtained a value of 1·4333 at 15° C. as a mean of three measurements agreeing with the mean within one part in 6,000. Glazebrook and Skinner found a value 1·4342 volts at 15° C. by a method based on their previous determinations of the silver equivalent. Carhart and Guthe find that if their value of the silver equivalent, corrected by an observation of Kahle's to correspond with Glazebrook's method, is inserted in Glazebrook's calculations, the resulting value of the Clark cell is in close agreement with their own determination from the electro-dynamometer. All this seems to indicate that the experimental work is sufficiently exact to detect some uncertainty in the electro-chemical equivalents as now defined. The paper is published in the *Physical Review* for November, December, 1899.

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**New Year Honours.**—In the list of New Year Honours there are only two names which are of any special interest to electrical men. Captain Abney, C.B., F.R.S., is promoted to be K.C.B. of the most Honourable Order of the Bath (Civil Division), and Major-Gen. Festing, R.E., is made a C.B.

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**Westminster Electric Supply Corporation.**—Captain E. Ironside Bax has resigned the post of general manager to the above, and has been appointed a director. Mr. L. H. Hordern, who has been assistant manager for some years, has been appointed to the post of manager.

**Concrete as a Combustible.**—Some time ago we received reports to the effect that a mass of concrete had taken fire in the boiler house of the electricity works at Chester. At first we put these down to the over-heated imagination of the local reporter, but their recurrence and circumstantial nature led us to make inquiries of the resident engineer, Mr. F. Thursfield. To our surprise we found that our information was correct. The concrete used for the foundations of two of the boilers consisted of one part in seven of boiler ashes; the brick lining under the boilers was omitted in one place, so that the red hot soot lay in contact with the concrete. The latter became ignited, and the whole block, 8 feet deep, disintegrated; in consequence it was found necessary to pull down the brickwork of the boilers, and remove the whole of the concrete block. The possibilities opened up by this precedent are appalling; we have seen so-called fireproof floors built of similar materials—of what use will they be? The calorific value of the boiler *ashes* employed must have been considerable; and in the present scarcity of coal, engineers may find it worth their while to stoke with concrete! We commend this suggestion to the consideration of Mr. Crompton, owing to his well-known interest in cheap fuel. In view of the importance of the phenomenon, we should be glad to receive details of similar experiences—if, indeed, it is not without precedent.

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**The Ruskin Hall Movement.**—We have been asked to draw attention to the extension of this meritorious movement to the "provinces," which term, in this case, includes London. As some of our readers are doubtless aware, the object of the movement is to bring some of the exceptional advantages of Oxford within the reach of working men. The work is carried on both by residence and by correspondence, and in addition to the original Ruskin Hall at Oxford, provincial Ruskin Halls are to be established, where young unmarried men may reside together at small cost, and prosecute their studies when not engaged in their ordinary occupations. Further, they will contribute to the maintenance of such of their number as are able to go, by turns, for a short time to Oxford, and they will form a library for their own use and that of the other correspondence students in their neighbourhood, who will contribute a small fee for the privilege. Full particulars may be obtained from the secretary, Mr. H. B. Lees-Smith, Ruskin Hall, Oxford.

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**Obituary.**—We regret to announce the death of Mr. Dieudonné Rigole, which occurred at Brussels some days ago. Dr. Rigole, who was an eminent chemist, was well known at Singapore, Java, and the North Borneo and other places in the Far East, being a personal friend of many of the Rajahs. A Brussels correspondent informs us that he was the first to experiment with the leaves of the gutta-percha plant. He foresaw that if the present system of destroying the plant continued, the increasing demand for gutta-percha would ultimately render it extinct. We understand that during the past year he has succeeded in producing very good gutta-percha by his process, in conjunction with Mr. Douglas Wells, at some works near Brussels. We are informed that the process has been favourably reported upon by several French and German chemists, and has been tested by cable manufacturers, who have investigated the probable saving, &c., to be effected by substituting his product for gutta-percha for submarine cables. It is further stated that Mr. Douglas Wells and his colleague, Mr. Berthelot, are making further extensive experiments in the same direction. Dr. Rigole has passed away just as his hopes seemed about to be realised.

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**Rumour Contradicted.**—As we go to press the Northern Electric Wire Company, of Halifax, sends us the following:—"It having come to our ears that a rumour is current that this firm is in liquidation, we should esteem it a favour if you will kindly give a contradiction in your next issue, and point out that we have no connection whatever with the late 'Northern Electric Wire and Cable Manufacturing Company, Limited, Square Road, Halifax. The sole proprietors of our firm are Messrs. Frank and Riley Patchett, and the business will be carried on as heretofore at Sedburgh Mills, Halifax."

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**Appointment Vacant.**—A meter inspector is wanted for West Ham. See "Official Notices" to-day.

**Cable Companies' Dinner.**—The sixth annual dinner of the cable companies was held on Monday last in the Queen's Hall of the Three Nuns' Hotel, Aldgate. Mr. W. James (Commercial Company) presided, while Mr. J. Salter (Great Northern Company) occupied the vice-chair. The dinner was followed by a smoking concert, during which Mr. Brooks sang "The Absent-Minded Beggar," and a liberal collection was made for the Widows' and Orphans' Fund.

## NEW COMPANIES REGISTERED.

**Improved Britannia Motors, Limited** (64,537).—This company was registered on December 18th, with a capital of £100,000 in £1 shares, and to manufacture and deal in and act as factors of and agents for the sale of motors of every description, cycles, bicycles, tricycles, velocipedes, carts, wagons, vehicles, ships, boats, launches, batteries, accumulators, electrical and other apparatus and machinery, &c. The first subscribers (each with one share) are:—G. Evans, 4, Upper Chadwell, Street, E.C., manufacturer; C. A. Fritb, 47, Lizzee Road, Hornsey, secretary; A. E. Compson, 15, Copthall Avenue, E.C.; O. Richardson, 26, Canonbury Square, N., solicitor's clerk; A. E. Luscombe, 3, Grove Road, Leytonstone, Essex, clerk; J. A. Atherton, Kilnwood, Kingston-on-Thames, solicitor; and F. Sidney, 98, Sewaratone Road, Victoria Park, clerk. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, £100; remuneration £100 each per annum, and an extra £100 for the chairman.

**Electric Lighting Boards, Limited** (64,543).—This company was registered on December 18th, with a capital of £7,500 in £1 shares, to acquire from E. O. Sachs and to turn to account certain existing inventions relating to electric lighting boards designed more especially for the purpose of luminous advertisements. The first subscribers (each with one share) are:—J. H. Oliver, 2, Beresford Villas, Park Terrace, Southend-on-Sea, cashier: W. Bridge, 43, Appach Road, Brixton Hill, S.W., clerk; B. Blewitt, 32, Grove Road, Wanstead, articled clerk; J. Feil, 21, Hayter Road, Brixton, S.W., secretary; H. G. Trew, 213, Barry Road, Dulwich, S.E., clerk; S. C. Whittle, 40, Carlingford Road, N., accountant; and J. Lewis, 2, Kemsing Road, Westcombe Park, Kent, secretary. The number of directors is not to be less than three nor more than seven; the first are Sir H. Nicholson, K.C.B., E. S. Enoch, and E. O. Sachs; qualification, £50; remuneration, £100 for the chairman, and £50 each for the others, with a share in the profits.

**Southern Electric Free Wiring Company, Limited** (64,550).—This company was registered on December 19th, with a capital of £5,000 in £1 shares, to carry on the business of electricians, mechanical and electrical engineers, contractors, metal workers, smiths, &c. The first subscribers are:—H. J. Weston, 24, Portland Street, Southampton, civil engineer, 100 shares; G. W. Capper, Westbourne, Barnes Close, South Cross, Winchester, timber merchant, 100 shares; T. McDonnell, 4, Bellevue Terrace, Southampton, auctioneer, 15 shares; T. Mitchell, Blenheim Lodge, West Park, Southampton, grocer, 25 shares; J. H. Laidman, "Bloomsgrove," Obelisk Road, Woolston, 25 shares; T. Miell, jun., 30, Hanover Buildings, Southampton, auctioneer, 25 shares; and H. J. Richards, 12, Chamberlayne Place, Southampton, 25 shares. The number of directors is not to be less than three nor more than five; the first are H. J. Weston (chairman), G. W. Capper, J. H. Laidman, T. Mitchell, and H. J. Richards; qualification, £25; remuneration as fixed by the company.

**Keynsham Electric Light and Power Company, Limited.**—This company was registered on December 29th, with a capital of £5,000 in £1 shares, to adopt and carry into effect an agreement with the Western Counties Electric Light and Power Syndicate, Ltd., and its liquidator, and to carry on the business of an electric light and power company in all its branches. The first subscribers (each with one share) are:—H. A. H. Daniel, F.S.I., Bank Chambers, Era Street, Bristol, surveyor; W. R. Wansbrough, Lion Chambers, Broad Street, Bristol, solicitor; F. B. Bond, 51, Corn Street, Bristol, architect; C. E. W. Berry, 50, Broad Street, Bristol, solicitor; E. T. Collins, 39, Broad Street, Bristol, F.C.A.; J. E. Mills, 91, Hampton Road, Redland, Bristol, banker; and C. J. T. J. Parfitt, The Avenue, Keynsham, Somerset, electrical engineer. The first directors (to number not less than two nor more than five) are H. A. H. Daniel, H. R. Wansbrough, and F. B. Bond; qualification, £50; remuneration as the company may decide.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Mutual Telephone Company, Limited** (56,627.)—This company's annual return was filed on December 29th, 1899, when 16,466 shares had been taken up out of a nominal capital of £250,000 in 50,000 £5 shares; 6d. per share has been called up, and £1,102 15s. has been received, including £691 2s. paid in advance of calls.

**Southern Electrical Installation and Wiring Company, Limited** (63,116).—This company's annual return was filed on December 21st, when 1,853 preference and 3,493 ordinary shares were taken up out of a nominal capital of £10,000 in 2,500 preference and 7,500 ordinary shares, all of £1 each. 15s. has been called up on each of 422 preference and 2,824 ordinary shares. £2,399 12s. 6d. has been paid, leaving £34 17s. 6d. in arrears. £2,100 is considered as paid on 1,431 preference and 669 ordinary shares.

## SUPPLY STATION ACCOUNTS.

### Bristol Corporation Electricity Accounts.

THE accounts of the electricity undertaking of the Bristol Corporation show most encouraging results, and indicate a rapidly growing business. With an increase in capital expenditure of £47,000, the output has risen by over 450,000 units and the load by nearly 700 KW. In other words, the increase for 1898 over 1897 in these figures would alone be considered good as the total figures for many provincial stations. The actual figures are given below:—

GENERAL STATEMENT.

| | 1897. | 1898. | Increase. |
|---|---|---|---|
| Total capital expenditure ... | £145,557 | £192,653 | £47,096 |
| Number of units sold ... ... | 910,888 | 1,362,786 | 451,898 |
| Maximum load in kilowatts ... | 1,010 KW. | 1,707 KW. | 697 KW. |
| Gross revenue ... ... ... | £20,570 | £26,112 | £5,542 |
| Gross profit ... ... ... | £11,217 | £12,631 | £1,414 |
| Average price per unit sold ... | 4·99d. | 4·24d. | −·75d. |

The revenue totals up to the substantial figure of over £26,000, of which nearly £900 is due to meter rents and over £1,000 is attributable to supply of lamps, keeping in order and trimming the public lamps and similar work done by the department. An additional item appears for rents received, advertising in pamphlets, and such like, but the "surplus lands" are no doubt a diminishing quantity, and therefore the amount so received is falling off. We do object, however, to the way that improvers' premiums are treated. Out of £200 received from this source the engineer appears to have been given £60 and a part was returned in wages (or, as we should prefer to say, salaries). Surely these men save the Corporation engaging others at much higher remuneration; and, if so, we think that the more usual course of leaving the engineer to deal with the pupils is at once fairer and more dignified.

REVENUE STATEMENT.

| | 1897. Gross. | 1897. Per unit. | 1898. Gross. | 1898. Per unit. | Increase. |
|---|---|---|---|---|---|
| Sale of current .. | £18,944 | 4·93d. | £24,071 | 4·24d. | −·75d. |
| Meter rents .. .. | 684 | ·18d. | 881 | ·16d. | −·02d. |
| Supply of lamps, &c. | 545 | ·14d. | 1,018 | ·18d. | +·04d. |
| Rents received, &c... | 306 | ·08d. | 69 | ·01d. | −·07d. |
| Sundry fees, &c. .. | 91 | ·03d. | 73 | ·01d. | −·02d. |
| Gross revenue | £20,570 | 5·42d. | £26,112 | 4·60d. | −·82d. |

Coals in the costs sheet shows a slight fall per unit, and although one might have expected this to exceed ·01d., we believe that this is a real improvement, as it has been stated that the cost of coal per ton over the last year was 15½ per cent. more than in 1897. The coal consumed per unit has been reduced by 18 per cent., but the general rise in price caused the money figure to remain practically the same. We are surprised to note the rise in "Oil, Waste," but all other important items are tending downwards.

COST OF PRODUCTION.

| | 1897. Gross. | 1897. Per unit. | 1898. Gross. | 1898. Per unit. | Increase |
|---|---|---|---|---|---|
| Coal .. .. .. .. .. | £3,320 | ·87d. | £4 901 | ·86d. | −·01d. |
| Oil, waste, water, and engine room stores. | 425 | ·11d. | 676 | ·12d. | +·01d. |
| Salaries and wages incurred in generation and distribution. | 2,226 | ·59d. | 2,858 | ·50d. | −·09d. |
| Repairs and maintenance of buildings, engines, boilers, dynamos, &c. | 609 | ·16d. | 1,363 | ·24d. | +·08d. |
| Works' cost ... ... | £6,580 | 1·73d. | £9,793 | 1·72d. | −·01d. |
| Rent, rates and taxes .. | 1,024 | ·27d. | 1,362 | ·24d. | −·03d. |
| Management and expenses, salaries of managing engineer, secretary, clerks, &c. | 1,193 | ·31d. | 1,477 | ·26d. | −·05d. |
| General establishment charges, stationery and printing, law charges and insurance | 338 | ·09d. | 575 | ·10d. | +·01d. |
| Other expenses .. .. .. | 213 | ·06d. | 269 | ·05d. | −·01d. |
| Total costs ... | £9,353 | 2·46d. | £13,481 | 2·37d. | −·09d. |

Bristol is one of the places where the business management has been good, as might be anticipated from the published remarks of Councillor Pearson. No attempt has, therefore, been made to supply energy below cost price. At 4½d. per unit, the public have no ground for complaint, and the resulting revenue enables depreciation and

revenue funds to be kept as they ought to be, but very often are not in other places. The reserve fund and the depreciation account each get £2,000 out of net profits; the balance between the figure shown in the "Profit Statement" below and the £4,000 necessary being made up by transfer from previous year's net profits carried forward.

Profit Statement.

| | 1897. | 1898. |
|---|---|---|
| Interest on loans .. .. .. .. .. | £3,742 | £4,407 |
| Sinking fund for repayments .. .. .. | 4,400 | 6,400 |
| Net profit carried to reserve fund and depreciation account equally .. .. .. | 3,075 | 1,324 |
| Gross profit ... ... | £11,217 | £12,631 |

## CITY NOTES.

### The Clontarf and Hill of Howth Tramroad Company.

On 29th ult. an extraordinary meeting of the shareholders of the Clontarf and Hill of Howth Tramroad Company was held in Jury's Hotel, College Green, Dublin, for the purpose of authorising the issue of debentures under the company's borrowing powers with the object of bringing the works of the line to a completion.

Sir Francis Brady, who occupied the chair, said that they were met for the purpose of authorising the contractors to exercise the borrowing powers conferred on the company by the issue of debentures. The works were in progress and money was required to carry them to completion. A large sum was due to the contractor, and for the purpose of providing that money it had become advisable to exercise the borrowing powers. He would accordingly move that the sum of £25,000 authorised to be borrowed by the company's Act be borrowed or raised on either mortgage or bond or by the issue of debenture stock, in such manner and at such time or times and on such terms as the directors of the company shall determine, the rate per cent. per annum on such mortgage bonds or debenture stock respectively not to exceed £4 10s. The chairman held in his hand a report from the engineer of the line, Mr. Frazer, showing how far the works had progressed. The report showed that the line had been laid with the exception of 100 yards at the Howth end. The principal item yet to be done was the erection of the car shed. The poles had been erected and were ready to receive the wires; the electrical equipment for the cars had been delivered, and the lines should be ready for the Board of Trade inspection in the month of March.

The resolution was carried unanimously.

### The Wireless Telegraph and Signal Company.

A general meeting of this company was held last Friday at the offices, 28, Mark Lane, E.C.

Major Flood Page, the managing director, proposed that the meeting be adjourned till some day in January or February, 1900, to be appointed by the directors. The reason, he said, was that the directors were of the opinion that it was very much in the interest of the shareholders that the meeting should not take place till a later date. This was agreed to.

**United River Plate Telephone Company.**—The directors recommend an interim dividend for the six months ended September 30th on the ordinary share capital at the rate of 5 per cent. per annum.

## TRAFFIC RECEIPTS.

**Blackpool and Fleetwood Tramroad Company.**—The receipts for eight days ending December 31st, 1899, were £213 10s. 11d.; December 23rd, 1898, £216 19s. 0d.; aggregate for half-year to date, £20,297 9s. 1d.

**The Bristol Tramways and Carriage Company, Limited.**—The receipts for the week ending December 29th, 1899, were £3,048 11s. 9d.; corresponding period, 1898, £3,194 15s. 4d.; decrease, £146 3s. 7d.

**The City and South London Railway Company.**—The receipts for the week ending December 31st, 1899, were £966; ditto, January 1st, 1899, £1,036; decrease £70. Total receipts for half-year, 1899, £26,961; total receipts corresponding period, 1898, £27,002; decrease, £41. Miles open, 5¼.

**The Dover Corporation Tramways.**—The receipts for the week ending December 23rd, 1899, were £151 7s. 11d.; December 24th, 1898, £146 7s. 8d.; increase, £5 0s. 3d. Total receipts to date, 1899, £9,8·6 5s. 10d.; corresponding period, 1898, £8,355 10s. 8d.; increase, £1,530 15s. 2d. Miles of track open, 1899, 3; 1898, 3. Car miles run, 1899, 4,478; 1898, 4,812. Number of cars, 1899, 11; 1898, 11. Week ending December 30th, 1899, were £158 2s. 0d.; December 31st, 1898, £193 12s. 10d.; decrease, £35 10s. 10d. Total receipts to date, 1899, £10,044 7s. 10d.; corresponding period, 1898, £8,549 3s. 6d.; increase, £1,495 4s. 4d. Miles of track open, 1899, 3; 1898, 3. Car miles run, 1899, 3,958; 1898, 4,120. Number of cars, 1899, 11; 1898, 11.

**The Dublin United Tramways Company.**—The receipts for the week ending Friday, December 29th, 1899, were as follows:—D. U. T. Co., horse cars, £120 12s. 5d.; ditto, electric cars, £2,987 19s. 5d.; D. S. D. Co., electric cars, £664 16s. 7d.; total, £3,773 8s. 5d.; corresponding week last year—D. U. T. Co., horse cars, £2,327 18s. 3d.; ditto, electric cars, £648 8s. 11d.; D. S. D. Co., electric cars, £785 9s. 11d.; total, £3,671 17s. 1d.; increase, £11 11s. 4d. Aggregate to date, £107,525 16s. 6d.; aggregate to date last year, £102,004 12s. 10d.; increase to date, £5,521 3s. 8d. Worked:—The mileage open is 40 miles electrically, 4 miles by horses, as against 16 miles electrically, and 28 miles by horses, for the corresponding period last year.

**The Halifax Corporation Tramways.**—The receipts for the week ending December 31st, 1899, were £514; January 4th, 1899, £265; increase, £249. Number of cars, 1899, 28; 1898, 10. Total receipts to date, from April 1st, 1899, £23,308; 1900, from June 29th, 1898, £7,118. Miles of track open, 12; 1900, 3¼.

**The Liverpool Overhead Railway Company.**—The receipts for the week ending December 31st, 1899, amounted to £1,305; corresponding week last year, £1,291; increase, £14.

**The South Staffordshire Tramways Company.**—The receipts for 9 days ending December 31st, 1899, were £1,021 2s. 9d.; 8 days ending December 31st, 1898, £954 10s. 8d.; aggregate receipts for year 1899, £34,822 16s. 11d; 1898, £33,142 16s. 7d.

## STOCKS AND SHARES.

Wednesday Evening.

With the entrance of a New Year a distinctly brighter tone has developed in the electrical markets, as in other departments of the Stock Exchange. To this there are several contributory causes. The money market has become a little easier, the internal troubles of the Stock Exchange have been smoothed down, the war news from South Africa is more promising, and altogether the situation is clear of a good many irritants which have lately been so much in evidence. While the changes in price are slight, there is a healthier feeling abroad, and the dealers are more ready to buy shares now that the stream of selling has for the time being run dry. It is time to consider whether some of the electrical stocks and shares are not at a reasonable level for the purchaser to make judicious selections with some hope of ultimate profit.

The electrical railway department is too sluggish and deserted to offer much scope for a buyer. Of the few specialities dealt in in this market, perhaps City and South London Ordinary would turn out the best investment in the long run. There is a dividend due next month. Owing to the new capital which now ranks for dividend, and which has not yet commenced earning anything, it is possible that the dividend rate may have to be reduced, although the directors are not likely to pursue such a course unless absolutely compelled. The price of the stock is standing at a lower level than it has touched since 1897. As a lock-up, the stock will probably prove remunerative, but a further sagging away in the price during the next few weeks is not unlikely.

In the telegraph market, Eastern Ordinary naturally presents itself as a hopeful investment of the speculative type. The price of the stock has been unduly depressed by causes into which we have gone too recently to need reiteration, and it now stands in the neighbourhood of 146. At this figure, and on the basis of last year's dividends, a buyer of the stock would receive the excellent rate of nearly 4½ per cent. on his money. Of course, the time will come for the All-British cable to begin getting itself laid, but its completion cannot be accomplished for at least a couple of years, and, in the meanwhile, the Eastern Company is doing excellent business with the war news. To buy and hold for a 10 per cent. rise would not appear to be a very risky policy.

Anglo-American "A" and "B" stocks are more speculative. In February, 1899, the "A" stock received a dividend of 18s. per cent. for the whole year, and the market operators declare that at least 7s. per cent. more will be announced this year. The company has done well over the boom in Yankee Rails in the early summer, and the yacht race was another windfall for its coffers, while the trade of the United States in 1899 was something prodigious. At the same time, Anglo "A" is one of the gambling counters of the miscellaneous market, liable to be blown about by winds quite foreign to its merits, but the "B" stock, with its 6 per cent. Preferred dividend, is decidedly cheap at 114, yielding to the purchaser 5¼ per cent. on his cash. Brazilian Submarine at 14⅛ are also well worth attention in this department.

The supply market has steadied considerably, and there is no longer a rush to realise at any price which shares will fetch. Of activity it is too early to speak, for a little time must be given to the dealers to recover breath after the recent shake-out. In this section the heavier shares, such as the St. James's, Westminster's, and Notting Hill are the best to select for investment, but no particular advance in price can be expected until money eases off to some extent. City of London shares are too speculative an investment to consider in agitated times, and Charing Cross descriptions have an unsettled outlook ahead.

In making these suggestions it must be understood that only the fringe of each subject is touched. Before embarking upon the investments that we have pointed out, the purchaser would do well to go much deeper into the matter than we, in our limited space, can afford to do. But it frequently happens that the investor is bewildered by the multiplicity of stocks and shares into which he can put his money, and these few indications of what are likely to prove profitable channels for his cash will not, perhaps, be altogether useless.

## SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

| Present Issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1896. | 1897. | 1898. | Closing Quotation, Dec. 27th. | Closing Quotation, Jan. 3rd. | Business done during week ended Jan. 3rd, 1900. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 124,400£ | African Direct Telegraph, 4 % Debs. | 100 | ... | ... | ... | 100 —104 | 99 —103 xd | ... | .. |
| 25,000 | Amazon Telegraph, shares | 10 | ... | ... | ... | 3 — 4 | 3 — 4 | ... | ... |
| 125,000 | Do. do. 5 % Debs., Nos. 1 to 1,250 Red | 100 | ... | ... | ... | 85 — 90 | 85 — 90 | | ... |
| 905,560£ | Anglo-American Telegraph | Stock | £2 13s | 3 % | £3 9s | 62 — 65 | 64 — 67 | 67½ | 66½ |
| 3,047,220£ | Do. do. 6 % Pref. | Stock | £5 6s | 6 % | 6 % | 111 —113 | 114 —116 | 115½ | 112½ |
| 3,047,220£ | Do. do. Deferred... | Stock | ... | ... | 18s. % | 15⅝— 16½ | 17½— 17⅝ | 17⅝ | 16½ |
| 205,151 | Brazilian Submarine Telegraph | 10 | 7 % | 7 % | ... | 14 — 14½ | 14 — 14½ | 14 7/16 | 14⅜ |
| 75,000£ | Do. do. 5 % Debs. 2nd series, 1906 | 100 | ... | ... | ... | 107 —111 | 106 —109 xd | ... | ... |
| 44,000 | Chili Telephone, Nos. 1 to 44,000 | 5 | 4 % | 4 % | ... | 2 — 3 | 2 — 3 | ... | ... |
| 10,000,000$ | Commercial Cable | $100 | 8 % | 8 % | 8 % | 198 —202 | ... ... | ... | ... |
| 1,332,523£ | Do. do. Sterling 500 year 4 % Deb. Stock Red. | Stock | ... | ... | ... | 100 —103 | 101 —104 xd | 10 2½ | ... |
| 224,850 | Consolidated Telephone Construction and Manufacturing | 10/- | 2 % | 1½ % | 1 % | ⅛— ¼ | ⅛— ¼ | ... | ... |
| 16,000 | Cuba Telegraph | 10 | 8 % | 7 % | 8 % | 8½ — 9½ | 8½ — 9½ | 9⅜ | ... |
| 6,000 | Do. 10 % Pref. | 10 | 10 % | 10 % | 10 % | 19 — 20 | 19 — 20 | ... | ... |
| 12,931 | Direct Spanish Telegraph | 5 | 4 % | 4 % | ... | 4 — 5 | 4 — 5 | ... | ... |
| 6,000 | Do. do. 10 % Cum. Pref. | 5 | 10 % | 10 % | ... | 9 — 10 | 9 — 10 | ... | ... |
| 30,000 | Do. do. 4½ % Debs. | 50 | ... | ... | ... | 103 —107% | 101—105% xd | ... | ... |
| 60,710£ | Direct United States Cable | 20 | 3 % | 3½ % | 3½ % | 11½— 12 | 11½— 12 | 11 1/16 | ... |
| 120,000 | Direct West India Cable, 4½ % Reg. Deb. | 100 | ... | ... | ... | 101 —104 | 99 —102 xd | ... | ... |
| 4,000,000 | Eastern Telegraph, Ord. Stock | Stock | 6½% | 7 % | 7 % | 143 —148 | 145 —150 | 148 | 145 |
| 1,795,000 | Do. 3½% Pref. Stock | 100 | ... | ... | ... | 97 —100 | 96 — 99 | ... | ... |
| 89,900 | Do. 5 % Debs., repayable August, 1899 | 100 | 5 % | 5 % | ... | ... ... | ... ... | ... | ... |
| 1,432,268£ | Do. 4 % Mort. Deb. Stock Red. | Stock | 4 % | 4 % | ... | 115 —120 | 115 —120 | 115 | ... |
| 250,000 | Eastern Extension, Australasia, and China Telegraph | 10 | 7 % | 7 % | 7 % | 14½— 14⅝ | 14½— 15 | 14⅞ | 14 1/16 |
| 16,200£ | Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326 | 100 | 5 % | 5 % | ... | 99 —103 | 99 —103 xd | ... | ... |
| 64,400£ | Do. do. Bearer, 1,050—3,975, 4,327—6,400 | 100 | 5 % | 5 % | ... | 100 —103 | 100 —103 xd | ... | ... |
| 320,000£ | Do. 4 % Deb. Stock | Stock | 4 % | 4 % | ... | 116 —121 | 116 —121 | ... | ... |
| 85,100£ | Eastern and South African Telegraph, 5 % Mort. Deb., 1900 red. ann. drgs., Reg. Nos. 1 to 2,343 | 100 | 5 % | ... | ... | 99 —103 | ... ... | ... | ... |
| 46,500£ | Do. do. do. to bearer, 2,344 to 5,500 | 100 | 5 % | ... | ... | 100 —103 | ... ... | ... | ... |
| 300,000£ | Do. 4 % Mort. Debs., Nos. 1 to 3,000, red. 1909 | 100 | 4 % | ... | ... | 101 —104 | 101 —104 | 103 | ... |
| 200,000£ | Do. 4% Reg. Mt. Debs. (Mauritius Sub.) 1—8,000 | 25 | 4 % | ... | ... | 101 —104% | 101—104% | ... | ... |
| 180,227 | Globe Telegraph and Trust | 10 | 4½ % | 4½ % | 5½ % | 10⅜— 11¼ | 10⅜— 11½ | ... | ... |
| 180,042 | Do. do. 6 % Pref. | 10 | 6 % | 6 % | 6 % | 14⅜— 15¼ | 14⅜— 15¼ | 14⅞ | ... |
| 150,000 | Great Northern Telegraph, of Copenhagen... | 10 | 10 % | 10 % | ... | 31 — 33 | 31 — 33 | ... | ... |
| 86,300 | Halifax and Bermuda Cable, 4½% 1st Mort. Debs., within Nos. 1 to 1,200, Red. | 100 | ... | ... | ... | 100 —103 | 99 —102 xd | ... | ... |
| 17,000 | Indo-European Telegraph | 25 | 10 % | 10 % | 10 % | 48 — 52 | 48 — 52 | 52 | ... |
| 100,000£ | London Platino-Brazilian Telegraph, 6 % Debs. | 100 | 6 % | 6 % | ... | 106 —109 | 106 —109 | ... | ... |
| 71,000 | Montevideo Telephone, Limited, Ord., Nos. 1 to 71,000 | 1 | ... | ... | ... | ¼— ⅛ | ¼— ⅛ | ... | ... |
| 84,000 | Do. do. 5% Pref., Nos. 1 to 84,000 | 1 | ... | ... | ... | ⅜— 1 | ⅜— 1 | ... | ... |
| 490,000 | National Telephone, 1 to 490,000 | 5 | 5½ % | 6 % | 6 % | 4⅝— 4⅞ | 5 — 5¼ | 5 | 4 15/16 |
| 15,000 | Do. 6 % Cum. 1st Pref. | 10 | 6 % | 6 % | 6 % | 14 — 15 | 14 — 15 | ... | ... |
| 15,000 | Do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | 6 % | 14 — 15 | 14 — 15 | ... | ... |
| 250,000 | Do. 5 % Non-cum. 3rd Pref., 1 to 250,000 | 5 | 5 % | 5 % | 5 % | 5⅛— 5⅜ | 5⅛— 5⅜ | ... | ... |
| 1,329,471£ | Do. 3½ % Deb. Stock Red. | Stock | 3½ % | 3½ % | 3½ % | 100 —102 | 98 —100 xd | 99¼ | 99 |
| 171,504 | Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid | 1 | 5 % | 5 % | 5 % | ⅜— 1 | ⅜— 1 | ... | ... |
| 100,000£ | Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 | 100 | 4 % | 4 % | ... | 102 —105 | 101 —104 xd | ... | ... |
| 11,839 | Reuter's | 8 | 5 % | 5 % | ... | 7 — 8 | 7 — 8 | ... | ... |
| 8,381 | Submarine Cables Trust | Cert. | ... | ... | ... | 125 —130 | 125 —130 | ... | ... |
| 58,000 | United River Plate Telephone | 5 | 5 % | 6 % | ... | 4⅜— 5¼ | 4½— 5 xd | 4⅜ | ... |
| 151,733£ | Do. do. 5 % Debs. | Stock | ... | .. | ... | 105 —108 | 102 —105 xd | ... | ... |
| 200,000£ | West African Telegraph, 5 % Debs. | 100 | 5 % | % | ... | 99 —102 | 99 —102 | 102 | ... |
| 30,008 | West Coast of America, Nos. 1—30,000 and 53,001—53,008 | 2½ | ... | ... | ... | ½— 1 | ½— 1 | ... | ... |
| 150,000 | Do. do. 4% Debs., 1—1,500 gua. by Bras. Sub. Tel. | 100 | ... | ... | ... | 102 —105 | 100 —103 xd | ... | ... |
| 389,521 | Western and Brazilian Telegraph 4 % Deb. Stock Red. | Stock | ... | ... | ... | 104 —107 | 102 —105 xd | ... | ... |
| 88,321 | West India and Panama Telegraph | 10 | 1 % | 2½% | ... | ⅞— 1½ | ⅞— 1½ | ... | ... |
| 34,563 | Do. do. do. 6 % Cum. 1st Pref. | 10 | 6 % | 6 % | ... | 9¼— 9¾ | 9¼— 9¾ | ... | ... |
| 4,669 | Do. do. do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | ... | 7½— 8½ | 7 — 8 | ... | ... |
| 80,000£ | Do. do. do. 5 % Debs., Nos. 1 to 1,800 | 100 | 5 % | 5 % | ... | 106 —109 | 104 —107 xd | ... | ... |
| 158,100£ | Western Union of U.S. Telegraph, 6 % Ster. Bonds | 100 | 6 % | 6 % | ... | 98 —103 | 98 —103 | ... | ... |

## ELECTRICITY SUPPLY COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 19,661 | Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761 | 5 | ... | 4 % | 6 % | 7⅛— 8⅛ | 7⅛— 8⅛ | ... | ... |
| 12,000 | Do. do. 7 % Cum. Pref. | 5 | 7 % | 7 % | ... | 9 — 10 | 9 — 10 | ... | ... |
| 80,000 | Charing Cross and Strand Electricity Supply | 5 | 6 % | 7 % | 8 % | 9½— 10½ | 9½— 10½ | ... | ... |
| 20,000 | Do. do. do. do. Nos. 30,001—50,000 | 5 | ... | ... | ... | 9½— 10½ | 9½— 10½ | ... | ... |
| 20,000 | Do. do. do. do. 4½ % Cum. Pref. | 5 | ... | ... | ... | 5½— 6 | 5½— 6 | ... | ... |
| 84,000 | *Chelsea Electricity Supply, Ord., | 5 | 5 % | 6 % | 6 % | 7⅞— 8⅛ | 7⅞— 8⅛ | ... | ... |
| 100,000 | Do. do. do. % Deb. Stock Red.... | Stock | 4½ % | 4½ % | ... | 109 —111 xd | 109 —111 | ... | ... |
| 60,000 | City of London Electric Lighting, Ord. 40,001—100,000 | 10 | 7 % | 10 % | 6 % | 10 — 11 | 10 — 11 | 10⅜ | 10⅛ |
| 40,000 | Do. 6 % Cum. Pref., 1 to 40,000 | 10 | 6 % | 6 % | 6 % | 13 — 14 | 13 — 14 | ... | ... |
| 400,000 | Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid | ... | 5 % | 5 % | ... | 125 —130 | 122 —127 xd | ... | ... |
| 40,000 | County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000 | 10 | nil | nil | nil | 10 — 11 | 10 — 11 | 10½ | ... |
| 20,000 | Do. do. do. 6 % Pref., 40,001—60,000 | 10 | 6 % | 6 % | 6 % | 13 — 14 | 13 — 14 | 13½ | ... |
| 200,000 | Do. 4½% Deb. Stock, Prov. Certs (all paid) Rd. | ... | ... | ... | ... | 110 — 113 | 107 —110 xd | ... | ... |
| 26,100 | Edmundsons Elec. Corp., Ord. Shares | 5 | ... | 5 % | 7 % | 4⅜— 5½ | 4⅜— 5½ | ... | ... |
| 110,000 | London Electric Supply Corporation, Limited, Ord. | 3 | ... | ... | ... | 2½— 2¾ | 2½— 2¾ | ... | ... |
| 48,050 | Do. do. do. 6 % Pref. | 5 | ... | ... | 6 % | 5½— 6 | 5½— 6 | ... | ... |
| 100,000 | Do. do. do. 4% 1st Mt. Db. Stock Rd. | Stock | ... | ... | ... | 102 —104 xd | 102 —104 | 102 | ... |
| 62,500 | Metropolitan Electric Supply, 101 to 62,500 | 10 | 5 % | 6 % | 5 % | 13 — 14 | 13 — 14 | 14 | 13½ |
| 22,500 | Do. Nos. 62,501 to 85,000 | 10 | ... | ... | ... | 13 — 14 | 13 — 14 | ... | ... |
| 220,000£ | Do. 4½ % First Mortgage Debenture Stock | ... | 4½% | 4½% | ... | 117 —119 | 116 —118 xd | ... | ... |
| 6,452 | Notting Hill Electric Lighting | 10 | 4 % | 6 % | 6 % | 15½— 16½ | 15½— 16½ | ... | ... |
| 31,980 | St. James's and Pall Mall Electric Light, Ord. | 5 | 10½ % | 14½ % | 14½ % | 15 — 16 | 15 — 16 | ... | ... |
| 20,000 | Do. do. 7 % Pref., 20,081 to 40,080 | 5 | 7 % | 7 % | 7 % | 9 — 9½ | 9 — 9½ | ... | ... |
| 65,000 | South London Electricity Supply, Ord. | 5 | ... | ... | ... | 4¼— 4⅜ | 4¼— 4⅜ | ... | ... |
| 79,900 | Westminster Electric Supply, Ord., 101 to 80,000 | 5 | 9 % | 12 % | 12 % | 13½— 14½ | 13½— 14½ | ... | ... |

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

Unless otherwise stated all shares are fully paid. ‡ Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

## SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

### ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

| Present Issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1896. | 1897. | 1898. | Closing Quotation Dec. 27th. | Closing Quotation Jan. 3rd. | Business done during week ended Jan. 3rd, 1900. Highest. | Lowest. |
|---|---|---|---|---|---|---|---|---|---|
| 60,000 | Aluminium "A" shares, Nos. 1—60,000 ... ... ... | 1 | 10 % | 10 % | ... | 2¾— 3¼ | 2¾— 3¼ | ... | ... |
| 90,000 | Do. 4½ % 1st Mort. Deb. Stock Red. ... ... | Stock | ... | ... | ... | 95 —100 | 95 —100 | ... | ... |
| 30,000 | British Electric Traction ... ... ... ... ... | 10 | ... | ... | 6 % | 15 — 16 | 15 — 16 | 16 | ... |
| 30,000 | Do. do. 6 % Cum. Pref. 30,001—60,000 | 10 | ... | ... | ... | 12⅜— 13¼ | 12½— 13 | 12 13/16 | 12⅜ |
| 200,000 | Do. do. 5 % Perpetual Debenture Stock ... | Stock | ... | ... | ... | 125 —128 | 125 —128 | ... | ... |
| 40,000 | British Insulated Wire Ord., Nos. 1 to 40,000 ... ... | 5 | ... | ... | ... | 11½— 12½ | 11½— 12½ | ... | ... |
| 27,500 | Do. do. 6 % Cum. Pref. Nos. 1 to 27,500 ... | 5 | ... | ... | ... | 6½— 6⅝ | 6½— 6⅝ | ... | ... |
| 90,000 | Brush Elecl. Enging., Ord., 1 to 90,000 ... ... ... | 3 | nil | 3 % | 5 % | 1⅜— 2 | 1⅜— 2 | 1⅞ | ... |
| 90,000 | Do. do. Non-cum. 6 % Pref., 1 to 90,000 | 2 | 4 % | 6 % | 6 % | 2⅜— 2⅜ | 2⅜— 2⅜ | ... | ... |
| 125,000l | Do. do. 4½ % Perp. Deb. Stock ... | Stock | ... | ... | ... | 110 —115 | 110 —115 | ... | ... |
| 50,000 | Do. do. 4½ % 2nd Deb. Stock Red. ... | Stock | ... | ... | ... | 104 —107 | 102 —105 xd | ... | ... |
| 20,000 | Callender's Cable Construction shares, Nos. 1—20,000 ... | 5 | 10 % | 12½ % | 15 % | 12½— 13½ | 12½— 13½ | ... | ... |
| 20,000 | Do. do. 5 % Cum. Pref. ... ... ... | 5 | ... | ... | ... | 5½— 6 | 5½— 5⅝xd | ... | ... |
| 90,000 | Do. do. 4½ % 1st Mort. Deb. Stock Red. | Stock | ... | ... | ... | 113 —116 | 110 —115 xd | ... | ... |
| 213,533 | Central London Railway, Ord. Shares ... ... ... | 10 | ... | ... | ... | 9½— 10 | 9½— 10 xd | 9⅞ | 9⅝ |
| 61,083 | Do. do. Pref. half-shares ... ... | 5 | ... | ... | ... | 4½— 5 | 4½— 5 xd | 4 15/16 | 4⅞ |
| 71,447 | Do. do. Def. do. ... ... ... | 5 | ... | ... | ... | 4½— 5 | 4½— 5 xd | ... | ... |
| 855,000 | City and South London Railway ... ... ... ... | Stock | 1 1/16 % | 1⅛ % | 2¼ % | 59 — 62 | 59 — 62 | ... | ... |
| 37,000 | Do. do. Ord. shares, Nos. 22,501 to 60,000 £5 10s. pd. | 10 | ... | ... | ... | 3½— 4½ | 4½— 5½ | ... | ... |
| 32,098 | Crompton & Co., Nos. 1 to 32,098 ... ... ... ... | 3 | ... | ... | ... | 3½— 4 | 3½— 4 | 3 13/16 | ... |
| 100,000 | Do. 5% 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 Red. | ... | ... | ... | ... | 100 —103 | 98 —101 xd | ... | ... |
| 99,261 | Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261 | 5 | 5½ % | 6 % | 6 % | 2 — 2¼ | 2 — 2¼ | ... | ... |
| 17,139 | Do. do. do. "A" Shares, 01—017,139 | 5 | 5½ % | 6 % | 6 % | 3½— 4½ | 3½— 4½ | ... | ... |
| 344,023 | Do. do. do. 4 % Deb. Stock Red. ... | 100 | ... | ... | ... | 95 — 97 | 93 — 95 xd | ... | ... |
| 112,100 | Electric Construction, 1 to 112,100 ... ... ... ... | 2 | 5 % | 6 % | 6 % | 2 — 2¼ | 1¾— 2⅛ | ... | ... |
| 25,000 | Do. do. 7 % Cum. Pref., 1 to 25,000 ... | 2 | 7 % | 7 % | 7 % | 2⅜— 3¼ | 2⅜— 3¼ | ... | ... |
| 140,300 | Do. do. 4% Perp. 1st Mort. Deb. Stock ... | Stock | ... | ... | ... | 104 —107 | 104 —107 | ... | ... |
| 91,196 | Elmore's Patent Copper Depositing, 1 to 70,000 ... ... | 2 | ... | ... | ... | ⅝— ⅝ | ⅝— ⅝ | ... | ... |
| 9,600l | Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600 ... | 10 | 7 % | 7 % | 7 % | 10 — 12 | 10 — 12 | ... | ... |
| 30,000 | Henley's (W. T.) Telegraph Works, Ord. ... ... ... | 5 | 10 % | 12 % | 14 % | 12 — 13 | 12 — 13 | 12½ | ... |
| 15,000 | Do. do. do. 4½ % Pref. ... ... | 5 | 7 % | 7 % | 7 % | 5 — 5½ | 5 — 5½ | 5⅝ | 5 |
| 50,000 | Do. do. do. 4½ Mort. Deb. Stock... | Stock | 4½ % | 4½ % | ... | 111 —114 | 111 —114 | ... | ... |
| 50,000 | India-Rubber, Gutta-Percha and Telegraph Works ... | 10 | 10 % | 10 % | 10 % | 21 — 22 | 20½— 21½xd | ... | ... |
| 800,000 | Do. do. do. 4 % 1st Mort. Debs. | 100 | ... | ... | ... | 100 —104 | 100 —104 | ... | ... |
| 37,500 | †Liverpool Overhead Railway, Ord. ... ... ... ... | 10 | 2½ % | 3½ % | 3½ % | 8 1/16— 9 1/16 | 8½— 8¾ | ... | ... |
| 10,000 | † Do. do. Pref., £10 paid ... ... | 10 | 5 % | 5 % | 5 % | 13¼— 13¾ | 12⅜— 13¼ | ... | ... |
| 37,350 | Telegraph Construction and Maintenance ... ... ... | 12 | 15 % | 15 % | 15 % | 33 — 37 | 34 — 38 | 37 | 36 |
| 150,000 | Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ... | 100 | ... | ... | ... | 103 —106 | 102 —105 xd | ... | ... |
| 13,400 | Telegraph Manufacturing, Ord. Nos. 6,601 to 20,000 ... | 5 | ... | ... | ... | 9 — 10 | 9 — 10 | ... | ... |
| 13,400 | Do. do. 5% Cm. Prf. Nos. 6,601 to 20,000 | 5 | ... | ... | ... | 5¾— 6 | 5¾— 6 | ... | ... |
| 540,000l | Waterloo and City Railway, Ord. Stock ... ... ... | 100 | ... | ... | 3 % | 100 —103 | 101 —104 | 100 | ... |

† Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

## LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply, Ordinary £5 (fully paid) 8—10.
Brompton and Kensington, 4½% Debentures of £100, 104—107.
National Electric Free Wiring, 10s. paid, 4s.—6s.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 18—19.
Do. do. Pref. (£10 pd.), 10½—11.
Smithfield Market Electric, 1—3.

* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6%, £5 (fully paid), 7—7½. Debentures, 104—107. Dividend, 1898, on Ordinary Shares 10%.
Kidderminster and District Electric, Pref. (£6 pd.), 6—6½.
*T. Parker, £10 (fully paid), 18⅜.

**Bank rate of discount 6 per cent. (November 30th, 1899).**

## MARKET QUOTATIONS, Wednesday, January 3rd.

| CHEMICALS, &c. | | This week. | Last week. | Increase or Decrease. |
|---|---|---|---|---|
| a Acid, Hydrochloric .. .. | per cwt. | 5/- | 5/- | .. |
| a " Nitric .. .. .. | per cwt. | 22/- | 22/- | .. |
| a " Oxalic .. .. .. | per cwt. | 32/- | 32/- | .. |
| a " Sulphuric .. .. .. | per cwt. | 5/6 | 5/6 | .. |
| a Ammoniac, Sal .. .. .. | per cwt. | 40/- | 40/- | .. |
| a Ammonia, Muriate (crystal) .. | per ton | £29 | £29 | .. |
| a " " .. .. | per ton | £27 | £27 | .. |
| a Bleaching powder .. .. | per ton | £6 1 | £6 10 | .. |
| a Bisulphide of Carbon .. .. | per ton | £15 | £15 | .. |
| a Borax .. .. .. | per ton | £16 10 | £16 10 | .. |
| a Benzole (90 %) .. .. | per gal. | 7/- | 7/- | .. |
| a " (50/90 %) .. .. | per gal. | 5/6 | 5/6 | .. |
| a Copper Sulphate .. .. | per ton | £25 10 | £25 10 | .. |
| a Lead, Nitrate .. .. | per ton | £25 | £25 | .. |
| a " White Sugar .. .. | per ton | £31 | £31 | .. |
| a " Peroxide .. .. | per ton | £27 10 | £27 10 | .. |
| a Methylated Spirit .. .. | per gal. | 2/9 | 2/9 | .. |
| a Naphtha, Solvent (90 % at 160° C.) .. .. .. | per gal. | 5/6 | 5/6 | .. |
| a Potash, Bichromate, in casks.. | per lb. | 5d. | 4½d. | ½d. inc. |
| a " Caustic (75/80 %) .. | per ton | £24 | £24 | .. |
| a " Bisulphate .. .. | per ton | £35 | £35 | .. |
| a Shellac .. .. .. | per cwt. | 68/- | 68/- | .. |
| a Sulphate of Magnesia .. .. | per ton | £4 10 | £4 10 | .. |
| a Sulphur, Sublimed Flowers .. | per ton | £6 | £6 | .. |
| a " Recovered .. .. | per ton | £5 10 | £5 10 | .. |
| a " Lump .. .. .. | per ton | £5 | £5 | .. |
| a Soda, Caustic (white 70 %) .. | per ton | £7 10 | £7 10 | .. |
| Crystals .. .. .. | per ton | £3 | £3 | .. |
| a " Bichromate, casks .. | per lb. | 4¼d. | 3¾d. | ½d. inc. |
| **METALS, &c.** | | | | |
| Aluminium Wire, in ton lots .. | per ton | £294 | £294 | .. |
| b " Sheet, in ton lots.. | per ton | £191 | £191 | .. |
| p Babbitt's metal ingots .. .. | per ton | £70 to £125 | £70 to £125 | .. |
| c Brass (rolled metal 5" to 12") | per lb. | 8d. | 8d. | .. |
| c " Tube (brazed) .. .. | per lb. | 10d. | 10d. | .. |
| c " Wire, basis .. .. | per lb. | 8½d. | 8½d. | .. |

| METALS, &c. (*continued*). | | This week. | Last week. | Inc. or Dec. |
|---|---|---|---|---|
| f Ebonite Rod .. .. .. | per lb. | 8/- | 8/- | .. |
| f " Sheet .. .. .. | per lb. | 5/- | 5/- | .. |
| g Copper Bars .. .. .. | per ton | £85 | £85 | .. |
| g " Wire (basis price) .. | per lb. | 10½d. | 10½d. | .. |
| g " Sheet .. .. .. | per ton | £85 | £85 | .. |
| g " Rod .. .. .. | per ton | £85 | £85 | .. |
| n German Silver Wire .. .. | per lb. | 1/6 | 1/6 | .. |
| h Gutta-percha, fine .. .. | per lb. | 7/- | 7/- | .. |
| h India-rubber, Para fine .. | per lb. | 4/6½ to 4/7½ | 4/6½ to 4/7½ | .. |
| i Iron, Charcoal Sheets .. .. | per ton | £18 | £18 | .. |
| i " Pig (Cleveland warrants) | per ton | 65/8 | 64/6 | 1/2 inc. |
| i " Forgings, according to size | per ton | From £11 | From £11 | .. |
| i " Scrap, heavy .. .. | per ton | 50/- to 55/- | 50/- to 55/- | .. |
| i " Wire galvanised No. 8 .. | per ton | £14 5 | £14 5 | .. |
| g Lead, English Ingot .. .. | per ton | £16 12 6 | £16 10 | 2/6 inc. |
| g " " Sheet .. .. | per ton | £18 | £18 | .. |
| m Manganin Wire No. 28.. .. | per lb. | 8/- | 8/- | .. |
| g Mercury .. .. .. | per bottle | £9 12 6 | £9 12 6 | .. |
| d Mica (in original cases), small | per lb. | 2d. to 8d. | 2d. to 8d. | .. |
| d " " " medium | per lb. | 1/9 to 2/9 | 1/9 to 2/9 | .. |
| d " " " large | per lb. | 3/6 to 7/6 | 3/6 to 7/6 | .. |
| p Phosphor Bronze, plain castings | per lb. | 1/1 to 1/1¼ | 1/1 to 1/4 | .. |
| p " rolled bars & rods | per lb. | 1/1 to 1/4 | 1/1 to 1/4 | .. |
| p " r'l'd str'p & sheet | per lb. | From 1/3½ | From 1/3½ | .. |
| o Platinum .. .. .. | per oz. | £3 11 | £3 11 | .. |
| p Silicium Bronze Wire .. .. | per lb. | 10½d. to 1/ | 10½d. to 1/1 | .. |
| i Steel, Magnet, acc'd'g to desc'p'n | p. ton | From £15 | to £40 | .. |
| i Steel, Magnet, in bars .. .. | | £18 | £58 | .. |
| g Tin, block .. .. .. | per ton | £120 to £121 | £108 to £110 | inc. |
| g " foil .. .. .. | per lb. | nom. 1/7 | nom. 1/7 | .. |
| n " wire Nos. 1 to 16 .. .. | per lb. | 1/8 | 1/8 | .. |
| p White Anti-friction Metals— "White Ant" brand .. | per ton | £40 to £70 | £40 to £70 | .. |
| j Yarns, Cotton, Single 10lb. bundles | pr lb. | 7¾d. | 7¾d. | ½d. inc. |
| j " Best Flax, 6 lea. .. | per lb. | 5½d. | 5d. | ½d. inc. |
| j " Hemp, 8 ply 10 lbs. .. | per lb. | 3¾d. | 3¾d. | .. |
| j " " Russian, 10 lbs. | per lb. | 4½d. | 4½d. | .. |
| j " Jute, 180 lbs. rove .. | per ton | £14 | £14 | .. |
| k Zinc, Sheet (Vielle Montagne bnd.) | p.t. | £24 5 nett. | £24 5 nett. | .. |

Quotations supplied by
a Messrs. G. Boor & Co.
b The British Aluminium Company, Ltd.
c Messrs. Thos. Bolton & Sons.
d Messrs. F. Wiggins & Sons
e

Quotations supplied by
f The India-Rubber, Gutta-Percha, and Telegraph Works Company, Ltd.
g Messrs. James & Shakspeare.
h Messrs. Jackson & Till.
i Messrs. Bolling & Lowe.
j Messrs. Henry C. Yee & Co.

Quotations supplied by
k Messrs. Morris Ashby, Limited.
m Messrs. W. T. Glover & Co., Ltd.
n Messrs. P. Ormiston & Sons.
o Messrs. Johnson, Matthey & Co., Ltd.
p The Phosphor Bronze Company, Ltd.

# ON THE PROTECTION OF ELECTRIC POWER TRANSMISSIONS FROM LIGHTNING.*

By J. T. MORRIS.

The efficient protection of electric power circuits from interruption and damage due to lightning, is a subject the importance of which will be readily understood when the following facts are briefly considered.

Within the last half-dozen years expensive experience has shown in the case of some of the earlier power transmissions that when a heavy thunderstorm came on it was actually better to shut down the generating station temporarily than to run the great risk of having an armature burnt out or some similar mishap, owing to the fact that no thoroughly efficient arrangement had been devised for the protection of the line from damage caused by lightning.

To illustrate the demand for thorough protection, it may be stated that at the beginning of this year [1897] plant had been installed, by one firm alone, for the transmission of power by electricity at high voltage, the capacity of which exceeded 60,000 H.P., and which necessitated for its transmission some 400 miles of overhead three-phase circuits.

Electric traction has also largely developed of late years, there being at the present time, to give a rough estimate, some 12,000† miles of line; of these about 10,000 are in the United States.

In practically every case the power is transmitted by means of bare overhead wires, fixed to insulators carried on poles. Many of the power transmissions at high voltage go through open and mountainous country, subject at intervals more or less frequent to violent thunderstorms, which, should the line be unprotected, would inevitably cause a breakdown of the plant. Hence the problem of efficient protection from lightning of power circuits is a very important matter.

In this paper the author proposes to describe the various principles which are applied in lightning arresters now in use, giving examples of those arresters which are most commonly used for high voltage transmissions at the present time, and the methods of installing them.

In the first place, it must be borne in mind that the chief difficulty lies not in conducting the dangerous discharge to earth, but in preventing the arc started by the discharge from being maintained, and so practically short circuiting the generators in the power house, or, at any rate, seriously overloading them. This is due to the fact that the voltage required to maintain an arc across a given air gap is far less than that required to start an arc over the same gap. For example, a difference of potential of 10,000 volts alternating will spark a distance of not more than $\frac{1}{3}$th inch (see curve, fig. 1),‡ while

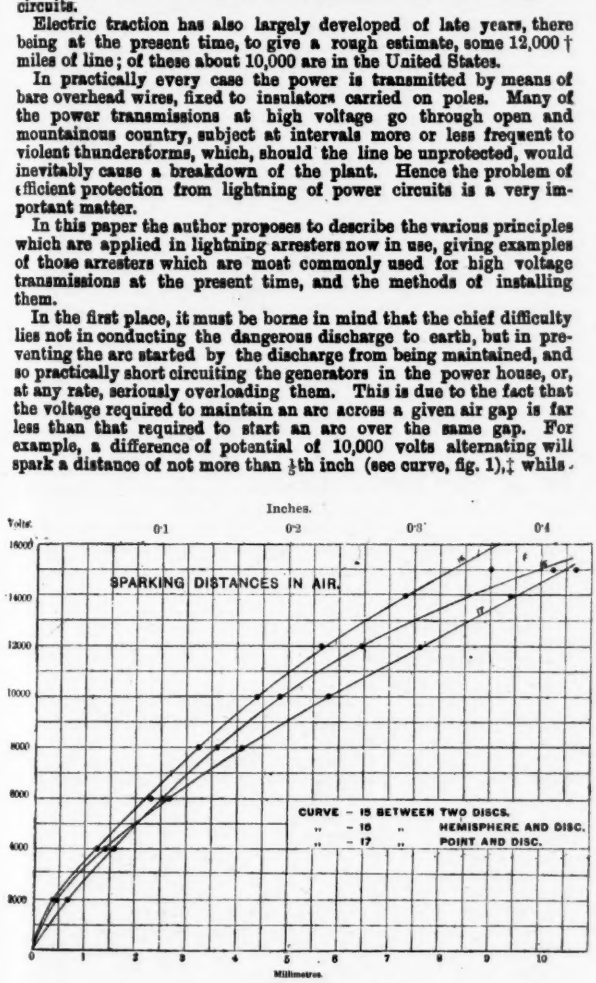



FIG. 1.

the same voltage will easily keep burning an arc of half a foot in length when once started. Similarly, 2,000 volts will only spark $\frac{1}{30}$th inch, while an arc at this voltage can be maintained of a much greater length.

In spark gap lightning-protecting devices the air gap must be decidedly greater than the sparking distance of the line pressure in use, in order that a continuous discharge of current to earth may be prevented.

There are at least three kinds of discharges due to atmospheric electricity, which ought to be disposed of safely by means of lightning arresters, protectors, or dischargers, as they are variously termed. They are as follows:—

1. Lightning actually striking the line
2. Induced rush or surgings in the line.
3. Slow accumulation of charge in the line.

1. *Lightning actually Striking the Line.*—When a powerful lightning flash actually *strikes* the line it is practically certain that no lightning arrester will save it. A case in point is one which occurred in America in 1894, where a plant was supposed to be safely protected by the most efficient arresters known; but a single and direct lightning discharge struck 20 consecutive poles on this line, hurling portions of these away to a distance of 150 feet, and at the power house one generator coil was burned out Fortunately this kind of discharge is only of rare occurrence.

2. *Induced Rush or Surgings in the Line.*—Under this head are included by far the greater number of line discharges. When an electric strain in the neighbourhood of a conductor is suddenly relieved by a lightning flash occurring at some distance from the line, a sudden rush of electricity takes place along the wire, and this may or may not oscillate or surge rapidly backwards and forwards along the line, giving rise at places to excessive differences of potential between the line and the earth, causing thereby a breakdown of insulation.

3. *Slow Accumulation of Charge in the Line.*—It is found in a number of cases when no thunderstorm is near and the sky is free from cloud, that the line gets slowly charged, and discharges across the spark gap in arresters at frequent intervals. This appears to be due to a charge accumulated from the air, which must be charged to a considerable extent with atmospheric electricity on such occasions.

Now, in order to protect the generators in the power house and other apparatus connected to the line from the effects of these discharges, a number of different plans have been adopted in various power transmissions, and the author intends to describe the most important of these in the following part of the paper.

Arrangements for preventing the lightning discharge entering the circuits:—A plan that is very commonly adopted on the Continent as well as in America, and with considerable success in places which are not exposed to exceptionally severe thunderstorms, is to stretch an iron wire along the whole length of the overhead line, at a height of from 12 to 18 inches above the conductors and to earth this at frequent intervals along the line.

For example, in the three-phase 10,000-volt power transmission from Eichdorf to Grünberg, in Silesia, a distance of 15 miles, the three wires carrying the three-phase current are fixed to insulators attached to the sides of the pole, whilst a barbed wire is run the whole length of the line along the top of the poles, and earthed at every sixth pole. The poles being 150 feet apart, this means that overhead the wire is earthed about six times per mile.

In the Niagara-Buffalo three-phase 10,000-volt transmission, 26 miles in length, which is now delivering power to the tramway company at Buffalo, galvanised and barbed iron wire is strung at a height of about 18 inches above the conductors and is grounded at every fifth pole; which, as the poles are placed about 70 feet apart, gives an earth per 350 feet of line, or some 15 times per mile.

## Lightning Arresters.

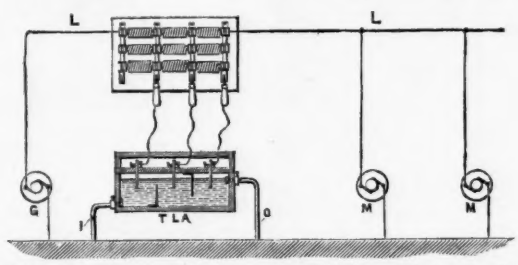
The term lightning discharger more strictly describes the function of this kind of apparatus; but since the word arrester is much more commonly used, it will be employed throughout the paper.

The object of lightning arresters is to get rid of any excessive electric differences of potential that may exist between the conductors and earth, and at the same time to prevent the current of the generators following in the path of the discharge from conductor to earth. In their design the chief points to be aimed at are rapidity of action, certainty of action, absence of moving parts, and simplicity, and further, that frequent inspection should be unnecessary.

They may be arranged in two groups, as follows—those which consist of a high resistance permanently connecting the line to earth, and those which contain a short air-gap, one terminal of which is connected to line, the other to earth.

Of these two groups by far the greater number of arresters belong to the second.

The principal example of the first group—those having a high resistance connecting the line to earth—is the Wurts tank lightning arrester. This device, which is largely used for 500-volt continuous current electric tramways, is shown in fig. 2, and consists principally




L, Line; G, Generator; I, Inlet; T L A, Tank lightning arrester; O, Overflow M, Motor.

FIG. 2.—WURTS TANK LIGHTNING ARRESTER.

of a galvanised iron tank having an outer covering of wood. This tank is connected to earth, and is full of water, into which dip three flat carbons. These carbons are connected electrically by means of

* Paper read at a students' meeting of the Institution of Civil Engineers, February, 1898. Awarded a "Miller" prize.

† This has since increased to about 19,000 miles, December, 1899.

‡ From Mr. Alex. Siemens' paper, entitled "Some Experimental Investigations of Alternate Currents," *Jour. Inst. E. E.*, Vol. xxi., Part 97, p. 179.

wires and plugs to three sockets in the "choke" coils, shown in fig. 3. The choke coils, of stout copper wire, are wound in the form of short spirals of some 10 turns, and hence they have a very small resistance

Fig. 3.—Choke Coils for Tank Arrester, 1,500 Amperes.

for continuous currents, which are used for operating the electric cars, whilst at the same time they offer an enormous resistance to any very sudden or rapidly varying current, such as a discharge of lightning.

The leakage current flowing from the dynamo to earth through this arrester would, if the water were left undisturbed, amount to 30 amperes or more at 500 volts. To diminish this loss, running water is fed through the tank from the ordinary water supply, thereby reducing the leakage current to about 12 amperes. A constant

Fig. 4.—Wurts Non-arcing Railway Lightning Arrester.

expenditure of 10 H.P., or thereabouts, is thus involved in the arrester. However, this loss need only occur during thunderstorms, for at other times the arrester may be cut out of circuit by drawing the plugs.

When it is considered that the generators are almost completely protected from lightning, this loss of power appears of little consequence.

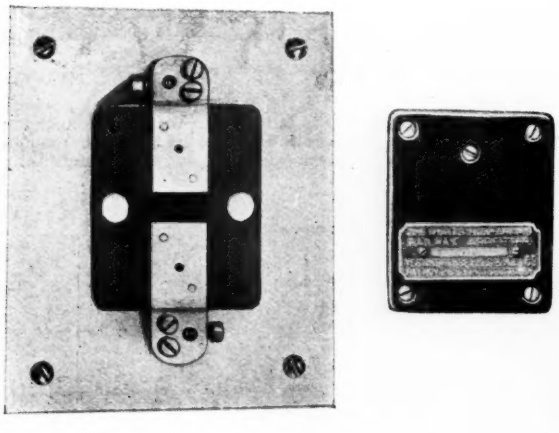


Fig 5.—Interior View of Wurts Lightning Arrester.

As before mentioned (in many cases) up to 1892 or 1893 it was the common practice in parts of the United States to shut down the plant during thunderstorms, and remove the trolleys from the line and wait till the storm was practically over. The direct loss occasioned by this practice has been known to exceed in one case at least £1,200 per year.

The only other arrester of importance which may perhaps be placed in this group is that known as the Wurts non-arcing railway lightning arrester (fig. 4.) It consists essentially of a high resistance formed out of a block of wood by a number of charred grooves on its surface (see fig. 5.) Two brass electrodes, half an inch apart, let into the wood are connected—the one to the line and the other to earth. On this arrangement is placed a cover, also of wood, which acts as a suppressor of any conducting vapour which a discharge might tend to produce. So that the discharge actually blows itself out the instant its passes; indeed, quite a sharp crack is made as each discharge goes to earth over the high resistance. The block, 3 inches wide by 3½ inches long, is made of lignum vitæ. The surface between the brass electrodes being channelled with nine grooves, each $\frac{1}{16}$-inch wide and $\frac{1}{32}$-inch deep. Its resistance to continuous currents at a pressure of 500 volts is over 50,000 ohms. The illustrations are of those constructed for station use. For use on the cars or line they are fitted with an iron case. These arresters are largely used in America with great success for direct current circuits up to 600 volts such as electric tramways.

Turning now to the second group, to which belong those arresters which contain a short spark gap, one side of which is connected to the line the other to earth; as mentioned above, arresters of this class constitute by far the greater number.

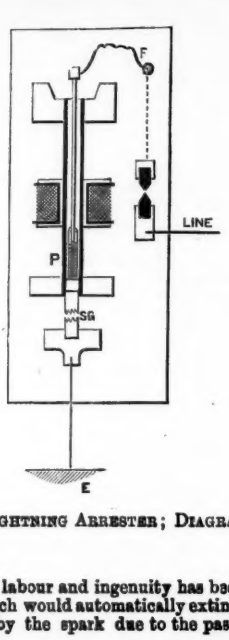



Fig. 6.—Garton Lightning Arrester; Diagram of Connections.

A large amount of labour and ingenuity has been expended in devising apparatus which would automatically extinguish the arc started across the air gap by the spark due to the passage of a lightning discharge.

The following table gives a fairly complete list of the various methods which are in actual use at the present time for extinguishing the arc so produced:—

| | | |
|---|---|---|
| Arc extinguished by | (1) | a switch controlled by an electro-magnet. |
| " " | (2) | sudden expansion of air actuating a switch. |
| " " | (3) | sub-division. |
| " " | (4) | cooling by contact with a mass of metal. |
| " " | (5) | tendency of heated air to rise, combined with action of current in conductor on arc. |
| " " | (6) | repulsion by an electro-magnet. |
| " " | (7) | use of non-arcing metals. |

These will now be taken in the above order, with examples of the application of these principles in existing arresters.

1. Arc extinguished by a switch controlled by an electro-magnet.

This division includes a number of arresters which have been used with varying success for power circuits. Of these only two will be described, viz., the Garton and the Thury.

*The Garton lightning arrester*, of American origin, is used on the Continent as well as in America for the protection of power circuits. The accompanying diagram, fig. 6, and description will render its mode of action clear. It consists of two carbon plates, separated by a small air gap, the lower plate being connected to earth. On the upper plate rests an iron core whose upper end is placed just within a solenoid. The core is connected electrically by means of a flexible wire at the top in series with this solenoid, which, in its turn, is connected to the overhead line. The solenoid is shunted by an air gap between two carbon points, the gap being extremely small, indeed, the carbons may actually lightly touch each other. The method of operation is as follows:—The discharge current of very high tension will chiefly go to earth from the line by the carbon points, iron core, and carbon plates, but the line current following will go through the solenoid, instead of the carbon points, owing to the resistance of the coil being much lower than that of the carbon points. The solenoid then attracts its core, and interrupts the circuit between the upper carbon plate and the iron core. The arrester then re-sets itself. These arresters can be used either for continuous or alternating current circuits.

*(To be continued.)*

## THE BERTHIER METHOD OF COAL CALORIMETRY.

IN a paper just presented to the American Society of Mechanical Engineers Mr. C. V. Kerr gives some figures relative to the Berthier method of calorimetry. This method has certain advantages in approximate work in that it dispenses with corrections and with delicate measurements of temperature. It consists simply in heating in a clay crucible the fuel to be determined and lead oxide (Pb O) at a low red heat. The fuel is finely powdered and mixed with an excess of the oxide. The lead reduced from the oxide collects in the bottom of the crucible and the button found after cooling off is weighed. The weight of pure lead thus obtained is obviously a measure of the oxygen absorbed by the fuel tested, the weight of which being accurately taken before the test enables the calorific capacity of the fuel to be known. It is, of course, important that the litharge should be pure, unmixed with red lead. Pure litharge is dull lemon or buff coloured. The Berthier system is based on Welter's law that the quantities of heat emitted by combustible substances are exactly proportioned to the amounts of oxygen required for their complete combustion. This, of course, is not strictly true at ordinary temperatures, especially in respect of gases which may have the same constituents but differently built up and varying in their endothermic or exothermic properties. Similarly, also, hydrogen differs very widely from carbon, and the Berthier method is not applicable to bituminous coals.

The author goes on to show that the Berthier method may still be fairly well applied to coals whose composition is already known approximately. For each unit weight of lead produced there are evolved 423·4 heat units when carbon is the fuel. Then the calorific capacity of a fuel will be represented by $423{\cdot}4 \times \frac{L}{F}$ when L is the weight of lead and F the weight of fuel. The following is the method of finding the constant where 14,600 = the calorific capacity of carbon:—

$$2\,Pb\,O + C = CO_2 + 2\,Pb.$$

As Pb has the equivalent 206·9, we get $\frac{2\,Pb}{O} = \frac{4{\cdot}138}{12} = 34{\cdot}48$.

Therefore the heat per unit weight of lead produced will be 14,600 ÷ 34·48 = 423·4.

With hydrogen we have $Pb\,O + H_2 = H_2O + Pb$. Therefore

$$\frac{Pb}{H_2} = \frac{206{\cdot}9}{2{\cdot}02} = 102{\cdot}42$$

and $\frac{102{\cdot}42}{34{\cdot}48} = 2{\cdot}97$, whence $14{,}600 \times 2{\cdot}97 = 43{,}362$ heat units for the capacity of hydrogen, whereas, as a fact, it is 62,000.

It is necessary, therefore, to increase the constant for hydrogen to 434 for fuels containing 2 per cent. of hydrogen, while for 5 per cent. of hydrogen the constant becomes 450, and the formula is $P = 450\frac{L}{F}$.

An advantage of the system is the low cost of materials and apparatus required. The one need is careful weighing of the fuel and the lead button produced, and, of course, the purity of the lead oxide.

## REPAIRING A FLY-WHEEL.

ONE of the papers read before a recent meeting of the American Society of Mechanical Engineers has a double interest. It details how a fly-wheel 90 inches wide on its belt face and built up of 10 segments was strengthened by the addition of intermediate tension rods secured to plates attached to each side of the boss and to transverse plates attached across the middle of each rim segment by six reamed bolts through one of the transverse stiffening ribs. Owing to having been once overspeeded by the running away of the engine the rim segments had cracked at many points in the stiffening ribs near the arms. The chief interest of the paper probably lies in the revelation afforded of the system of construction thought sufficient for a 26 foot wheel weighing 30 to 40 tons. It had but one set of arms fixed to rectangular tables cast in the middle of each segment of the rim. These bolting tables are 37½ inches wide × 20 inches long, measured in the circumferential direction of the wheel. Obviously, therefore, the outer edges of the wheel have nothing to restrain them from flying outwards, excepting their own resilience, which is not much. This method of construction is cheap and nasty, but it is not by any means solely American. We have seen large rope rims built on the same principles—or lack of principles—in this country, and any serious excess of speed must be very dangerous where such large unsupported areas are dependent upon their own slight transverse strength.

In a companion paper to the above of Mr. McBride's, another author, Mr. Firth, suggests a form of construction which he considers better calculated to use the whole strength of a wheel. He points out that the arm tension in a wheel is usually only about 30 per cent. of the centrifugal tension in the rim, and he wishes to load up the arms to assist the rim. To this end he would use six arms, and the inside circumference of the rim is a series of arches from arm to arm. Thus the rim is deep over the arms where large bolting area is needed, and it is shallow between the arms.

The objection to this suggested method of construction comes in obviously in view of the fact that should an arm fail the destruction of the wheel would be prompt and certain, the rim breaking at the two contiguous arch crowns which would then be exposed to such severe cross-breaking stresses.

It appears better to design the arms simply as cantilevers to transmit the turning forces and to make the rims safe in themselves, and as perfectly homogeneous as possible to resist ring stresses. Thus in a wire-wound wheel there can be no transverse stresses, but the ring tensions are equal and uniform throughout if the rim is not tied down by the arms. In a wire-wound rim no part of the rim can act as a beam, for the lamination forbids any practicable amount of transverse resistance to bending, and if the arms are allowed to exercise any restraining effort the rim will simply assume the form of a series of tension arches. But if quite free from any arm restraint the wheel would assume a perfectly circular form when revolving, and would be enormously strong against bursting. As with wire guns, the full resistance due to wire drawing can be secured.

## FRICTION OF STEAM PACKINGS.

PACKINGS are numbered by the thousand, and yet the literature of engine packings is very meagre; possibly it is this very fact that accounts for the multiplicity of packings. An American engineer, Mr. C. H. Benjamin, of Cleveland, has recently been testing packings or having tests made upon them by students under his care at the Case Technical School. The apparatus employed consisted of a cast-iron cylinder 6 × 13 fitted at each end with a gland for a 2-inch rod, the gland being of ordinary good design copied from a well-known engine. The rod was given a reciprocating movement by suitable mechanism, and the cylinder contained steam so as to bring the experiment into the regions of actual practice. A transmitting dynamometer enabled the expenditure of power to be measured. The rod travel was 4½ inches and the usual speed 200 revolutions per minute—equivalent to 140 feet per minute linear velocity of rod. The packings tested were of the usual types, compounds of tape and rubber or canvas with some metallic rings and others graphite. No attempt was made to obtain endurance results, but each packing was run both dry and lubricated. The apparatus was first tested unpacked. Then it was packed and steam turned on and the nuts were screwed up by hand just enough to prevent leakage.

The general conclusions drawn from the tests are that the softer rubber and graphite packings, which are self-adjusting and self-lubricating, consume less power than the harder varieties: that the use of oil will reduce the friction with any packing: that there is almost no limit to the loss caused by injudicious screwing up of the gland: that the power loss varies almost directly with the steam pressure with hard packings but is nearly constant with soft packings.

The horse-power under the conditions varied from ·036 to ·400 at 50 lbs. pressure with a safe average of ·07 for the softer packings.

At a piston speed of 600 feet per minute the same friction would give a loss of ·154 to 1·71 with an average of ·30 H.P. at a mean pressure of 50 lbs.

The author proposes to continue the tests with water packings and some of the standard forms of metallic packings, and he invites criticisms and suggestions from makers and users.

## THE ELECTRO-CHEMICAL AND ELECTRO-METALLURGICAL INDUSTRIES IN 1899.

BY JOHN B. C. KERSHAW, F.I.C.

THE year 1899 has been marked by steady advancement in several of the industries with which this annual review of progress deals; and in one industry the growth has again been phenomenal.

The aluminium industry, the industries based upon the electrolytic decomposition of salt, and the copper refining industry, all exhibit signs of healthy expansion; while in the calcium carbide industry the rate of growth has been extraordinary, and, in the writer's opinion, has been too rapid to be sound.

No new electro-chemical or electro-metallurgical process of any industrial importance has been introduced to the public during 1899; but two processes, which were still in their experimental stage at the date of the last annual review* have since emerged, and works for their operation on a large scale are now in course of erection. One electro-chemical works has closed during 1899, and one other has, for the second time, met with difficulties which have necessitated the temporary cessation of manufacturing operations. As a set off to these failures, a large number of new factories for the operation of processes already at work on an industrial scale have been planned, and some of these have already commenced production.

The only litigation during 1899 has been that carried on

* ELECTRICAL REVIEW, January 13th, 1899.

between the Castner-Kellner Company and the Commercial Development Corporation with reference to the validity of the patents for the Rhodin cell. The judgment of 1898 has been reversed, on appeal, in favour of the latter company, but it is expected that the case will now be carried before the House of Lords.

The details for the separate industries are given below:—

### Alkalies and Bleach.

No new electrolytic alkali processes have come under the writer's notice in 1899, beyond those which form the subject of patent applications only. As space is limited and inventors are prolific, no attempt is made to deal with these in this review. The Greenwood process, to which reference was made a year ago, has not fulfilled expectations, and the trials at Winsford have been stopped.

The Rhodin process has made its reappearance in America, and the American Alkali Company, with a capital of £120,000, has been formed to work this process at Sault Ste. Marie. Electrical energy at this spot is estimated to *cost* only 42s. per E.H.P.-year. The Commercial Development Corporation receives £108,000 for the American patent rights of the Rhodin process and cell. For a patent which has not received, as far as the writer is aware, industrial trial, and may still have to face extended litigation, this price is undoubtedly satisfactory from the vendor's point of view. Whether the purchasers have reason to be equally satisfied with the bargain, is a question to which a decisive answer may be given two years hence.

The Hargreaves-Bird process has during 1899 entered upon the third and final stage of its development, a company, with a capital of £500,000, having been floated for purchase of the English patents, and erection of a works at Middlewich, in Cheshire. The new company—the Electrolytic Alkali Company—is to pay £100,000 to the Parent Company for the patent rights in the United Kingdom. The projected works at Middlewich will require about 3,500 H.P. (steam or gas-power will be used) and are estimated to cost £140,000. This process is now being operated industrially in France; the St. Gobain Chemical Company, after lengthy trials, having bought the French patent rights.

The Castner-Kellner process is developing rapidly, and there are now three works which use this process in operation—at Weston Point, Niagara, and Osternienberg—while two are building, the one at Jenappe, in Belgium, and the other near Moscow. The works at Weston Point have been completed during 1899, and 4,000 H.P. is now available for the production of alkalies and chlorine at this place. The total expenditure upon plant and machinery has been £292,000, and the capital of the company is being increased to £450,000. The operation of this works for the year 1898-99 was financially successful, and an 8 per cent. dividend has been declared. The Mathieson works at Niagara are also a success, and extensions are now in progress.

The Richardson & Holland process at St. Helens, as noted above, has met with further difficulties during 1899, and the works have been stopped for alterations and repairs during portion of the year.*

The processes worked by the "Elektron" Company at Griesheim, and by the Bitterfeld Company at Bitterfeld (both diaphragm processes), are extending even more rapidly than the Castner-Kellner process, as the following list of places, where works, using one or other of these processes, are in operation, will show:—Griesheim, Bitterfeld (2), Rheinfelden, Ludwigshafen, Westeregeln, Montiers, La Motte, Zombkowice, Slaviansk, and Flix, in Spain.

This progress has been independent of the amalgamation to which reference was made in the last report, of the two Parent Companies. During 1899 further changes in the financial organisation have been made, and the Allgemeine Elektricitäts Gesellschaft, of Berlin, is putting an additional £180,000 into the Parent Companies.

The Hulin process, at Clavause, in France, is reported to be working satisfactorily, but manufacture by this process has not yet been commenced in other countries.

The Kellner process at Hallein, in Austria, is still operated on a comparatively limited scale; arrangements have, however, been made during the past year for the provision of the capital required to complete the works as originally designed. The Le Sueur process, which has been operated since 1893 at Rumford Falls, U.S.A., has succumbed during 1899 to the fall in prices of heavy chemicals in New York, and the plant at this works has been stopped.

In addition to the processes named above, others of which no details are available are already being utilised, or are about to be utilised, at the following places:—St. Michel, Chevres, Monthey, Thusis, Cumberland Mills Michigan, and at two unnamed places in Italy and North America.

The electrolytic alkali and bleach works in operation in Europe and America will, therefore, shortly number 29. When one recalls the fact that 10 years ago there was not a single electrolytic alkali works in existence, the progress is seen to have been remarkable.

### Aluminium.

Although the number of works producing aluminium is now only six, the output of the metal is increasing; this increase being due to the concentration of the manufacture at the larger works.

The projected aluminium works at Sarpsfos, in Norway, is still unbuilt, the capitalists responsible for the developments at this place, having decided that calcium carbide is the more profitable product.

Owing to the refusal of the European Aluminium Companies to supply figures of their output for *publication*, the writer is unable to give any detailed production figures; but the *totals* for the three years 1896-97-98, are believed to have been as follows:—1896, 1,789 tons; 1897, 3,394 tons; 1898, 3,958 tons.

The price of aluminium has remained fairly stationary during 1899, and it is hardly probable that any material reduction in price can occur with the present methods of extraction. The price at which aluminium is being sold for conducting purposes, 14½d.—15d. per lb., will leave little or no profit to the producers.

There have been considerable additions to the capital accounts of the leading aluminium companies during the past year—the Pittsburg Company, the Foyers Company, the Neuhausen Company, and the Le Praz Company having all raised fresh capital for extensions during 1899.

As three of these companies have taken up the manufacture of calcium carbide, it is impossible to say what effect these increases will have on the aluminium industry.

No new process for the production of the metal has received industrial trial during the past year. The Peniakoff process, to which reference was made in the last review, has apparently failed to answer the expectations of those interested in it, for direct inquiry has failed to elicit any information concerning its progress. The only two processes for aluminium production in actual operation are, therefore, still the Hall and Herault processes.

The chief feature of 1899 with regard to the utilisation of aluminium has been the extension of its use for conducting purposes. Owing to the high price of copper during the past year, electrical engineers have been disposed to try the new metal, and in America especially a large number of aluminium transmission lines have been installed.

The behaviour of these eight aluminium power transmission lines, carrying, in the aggregate, 9,000—12,000 H.P. at pressures ranging from 10,000—29,000 volts, will be studied with interest by all electricians. The use of aluminium for telephone and electric light work is also being experimented with in this country, but the proverbial caution of our race hinders rapid progress in this direction.

With regard to other uses of aluminium, the most striking progress during the past year has been in connection with the application of aluminium to printing work.

As a substitute for stone it is rapidly gaining favour, and in both Germany and America "aluminography" is becoming a special branch of the printing industry.

There is little progress to report in other directions during 1899. The contributions of Ditte to the French Academie des Sciences have somewhat shaken the confidence in the durability of aluminium when exposed to atmospheric or other influences; and despite Moissan's defence of the new metal, it is felt that further practical trials are necessary. Abstracts of these papers by Ditte and Moissan appeared in issue of the Electrical Review for August 11th, 1899.

* Since writing the above the writer has learned that great improvements have been effected in this process during 1899; and the electrolytic plant at St. Helens is again in operation.

The use of powdered aluminium for production of ferro-chromium alloys has attained the dignity of an industrial process during the past year, and a works for manufacture of these alloys is now in operation at Essen.

With regard to its use for shipbuilding, aluminium has not made any marked advance during 1899; but both the *Columbia* and the *Shamrock* were stated to have considerable quantities of aluminium alloys in various parts of their hull structures.

The following is the lists of places where aluminium works are now in operation:—Niagara (2); Foyers, Neuhausen; Le Praz, Rheinfelden. 26,000 H.P. is available at these six works, but it is questionable whether more than one-half of this is employed at present in the production of aluminium.

### Calcium Carbide.

The year 1899 has been characterised by a continuance of the "boom" in the promotion of calcium carbide companies and factories which commenced in 1896, and has now extended over a period of three years. That this period of "boom" will be followed by the inevitable reaction is only too certain, and the writer would not be surprised if the year 1900 witnessed a collapse of the inflated prospects and values in the new industry. Nearly every water-power of any considerable size in Europe has now been turned to account for carbide production, and the competition between the larger factories must sooner or later cause a decisive fall in prices, and a very considerable reduction in the margin out of which dividends are to be paid.

However, for the present, "calcium carbide" manufacture is considered by capitalists and company promoters to be the most profitable of the electro-chemical or electro-metallurgical industries, and the promotion of new companies and the erection of new factories goes merrily forward.

In the report upon the calcium carbide industry which appeared in this paper 12 months ago, a list of 51 places was given where this product was already manufactured or where factories were in course of erection.

This list has now grown to 93. Limits of space forbid the detailed enumeration of these 93 places, but the totals for the different countries are as follows:—

*Calcium Carbide Works in Operation.*—France, 21; Switzerland, 11; Austria and Hungary, 8; Germany, 8; Italy, 7; United States, 6; United Kingdom, 4; Norway and Sweden, 4; Spain, 2; Russia, 2; Canada, 2; Belgium, 1. Total, 76.

*Calcium Carbide Works in Course of Erection.*—France, 5; Switzerland, 3; Austria and Hungary, 3; Norway and Sweden, 3; Italy, 1; Russia, 1; Canada, 1. Total, 17.

The extraordinarily rapid development of the carbide industry in Europe has been partly due to the action of the large German electrical engineering firms. These have actively promoted the formation of carbide companies, and the erection of works for carbide production, in order to benefit by the orders for generating plant and machinery, and in many cases they have retained a large financial interest in the completed works. It is, however, questionable whether these investments will continue remunerative, and some unloading of carbide shares upon the public is certain to occur when the price of carbide falls.

No safe estimate of the power available for carbide manufacture in these 93 works can be made, for a large number of them manufacture other products, and the proportion of the total power devoted to carbide is a matter of pure conjecture. Further, in the majority of cases the water-power is greatly reduced during the dry season, and in some cases the manufacture is wholly stopped for the summer months of each year. Estimates of the carbide production of the world at the present time must, therefore, be received *cum grano salis*. That the aggregate production of carbide is large, is unquestionable; that it is as large as some interested parties assert is doubtful.

The price of carbide has not undergone material change during 1899; the difficulties and costs of transport to some extent neutralise the effects of the increased production. It is, however, now practically proved that under favourable conditions as to the supply of lime and coke, and with cheap power, carbide can be produced for about £8 per ton. At Meran, in the Austrian Tyrol, the costs works out to £7 5s. per ton, inclusive of interest and depreciation charges. It is, therefore, evident that when production overtakes the demand, and the regulations regarding transport are improved, a very big fall in prices will occur. At present in this country the quotation is £18 per ton, f.o.r. at Foyers, but probably a considerable reduction is made for large quantities.

With regard to the utilisation of carbide, there is nothing of a striking nature to report. In this country considerable progress is being made with the installation of acetylene gas in country houses; and central installations of generating plant for the supply of considerable areas, have been carried out at Hawes, in Lancashire, at Filey, in Yorkshire, and at St. Michaels, in Kent. In Germany the new illuminant appears to be most largely used for railway station lighting; while in South-Eastern Europe acetylene is being adopted for lighting small towns. The progress of these central installations of acetylene generating plant will be watched with interest. That the cost of acetylene illumination at the present price of carbide is considerably higher per candle-power than the cost of coal gas or oil illumination is well known, and it would be wise if those responsible for these new developments would make this fact clear to their customers. Otherwise, the experience with acetylene lighting in Canada (see Electrical Review, October 6th, 1899) may be repeated in other countries.

The need for scientific advice and supervision in connection with these larger installations of acetylene generators, is evidenced by two occurrences of the past year.

In May, at the Buda-Pesth Acetylene Gas Exhibition, a fire was caused by the use of bleaching powder as a purifying substance for the crude gas; and in August the Wabash Ia. (U.S.A.) municipal lighting plant was entirely destroyed by explosion.

During 1899 there has been no litigation concerning carbide patents; and it would appear that the threatened proceedings on the part of the owners of the Wilson patents in this country against other firms are to be stayed. In view of the failure to uphold carbide patents in France and Germany, this policy of prudence is wise, though it may not commend itself to the members of the legal profession and to the "carbide experts," who would have been called upon to take part in the case.

*(To be continued.)*

## THE LEGAL RELATIONSHIP OF ELECTRIC LIGHTING AND POWER COMPANIES TO THE ROAD AUTHORITIES.

In order to discover the rules and regulations under which the company may acquire the right to place wires beneath the roadway it is necessary to refer to the Electric Lighting Act of 1882. In the first place, by Section 10 of that Act the undertakers may, subject as therein mentioned, and for the purpose of supplying electricity, acquire such lands by agreement, construct such works, acquire such licenses for the use of any patented or protected processes, inventions, machinery, apparatus, methods, materials, or other things, enter into such contracts, and generally do all such acts and things as may be necessary and incidental to such supply. The section confers upon the company the right to obtain lands, &c., by agreement, but compulsory powers are often required in order to obtain sites for stations, and the necessary leave to lay wires under the streets. This object is effected by Section 12, whereby the provisions of the Gasworks Clauses Act, 1847, with respect to breaking up streets for the purpose of laying pipes, &c., are incorporated with the Electric Lighting Act. It is necessary, therefore, to refer to those provisions, and to the cases which have arisen from time to time with regard to them for the purpose of showing the true relationship between electric lighting companies and the local authorities.

The following are the incorporated sections of the Gasworks Clauses Act, 1847:—

6. The undertakers, under such superintendence as is hereinafter specified, may open and break up the soil and pavement of the several *streets* and bridges within the limits of the special Act, and may open and break up any sewers, drains, or tunnels within or under such streets and bridges, and lay down and place within the same limits

pipes, conduits, service pipes, and other works, and from time to time repair, alter, or remove the same, and also make any sewers that may be necessary for carrying off the washings and waste liquids which may arise in the making of the gas, and for the purposes aforesaid may remove and use all earth and materials in and under such streets and bridges, and they may, in such streets, erect any pillars, lamps, and other works, and do all other acts which the undertakers shall from time to time deem necessary for supplying gas to the inhabitants of the district included within the said limits, doing as little damage as may be in the execution of the powers hereby or by the special Act granted, and making compensation for any damage which may be done in the execution of such powers.

The word "street" is defined in Section 32 of the Electric Lighting Act of 1882 to mean "any square, court, or alley, highway, lane, road, thoroughfare, or public passage or place within the limits of the special Act." The expressions "street" and "public" road include any highway. [See Telegraph Act, 1863, Section 2 of which is incorporated with the Act of 1882.]

### Definition of Highway.

In the case of an ordinary highway the right of passage extends to the whole space between the fences on either side, and the public are entitled to the use of the whole space as a highway, and are not confined to the metalled parts [R. *v.* U. K. Telegraph Co., 31 L.J.M.C., 166]. An important question sometimes arises as to whether the local authority can limit the space within which wires may be laid to the *carriageway* properly so called. The case of the Mayor, &c., of the Borough of Hyde *v.* the Oldham, Ashton and Hyde Electric Tramway, Limited, and others, is important in this connection. The action was brought for an injunction restraining the defendants from breaking open the footways along certain streets in the borough of Hyde and laying down electric cables thereunder for the purpose of using them for working tramways which the defendants had constructed.

The defendant company obtained the necessary powers by virtue of the Tramways Orders Confirmation (No. 2) Act, 1896. By Section 6 the promoters may, and so far as regards so much of the tramway as is to be laid within the borough of Hyde, shall within two years from the date of the provisional order, construct and maintain the tramways therein described. A plan for the construction of the tramways was authorised by the Board of Trade under Section 24 of the Act of 1896. This involved the laying down of cables or feeders under the footways of the streets traversed. On July 5th, 1898, the defendants gave notice to the plaintiffs of their intention to open the ground of the streets under the plaintiffs' control. Prior to this they had undertaken to pay £500 towards the cost of widening certain of the streets, but the plaintiffs refused to allow them to lay the wires under the footway unless they contributed a further sum of £500 towards the expenses of widening the street. This the defendants declined to do, and proceeded to lay the wires under the footway, in accordance with plans submitted by them to, and approved by, the Board of Trade.

It was contended on behalf of the plaintiffs that the defendants had no power to break up or open the footways without the plaintiffs' consent, inasmuch as the power given by Section 26 of the Tramways Act, 1870, to break up roads was limited by virtue of the definition in Section 3 to "the carriageway." The defendants argued that the definition of the word "road" in Section 3 did not exclude the footways where the highway consisted of a carriageway and footways. It was also urged that inasmuch as the work was completed, there was no case for injunction [(1899) 1 Ch., 474. Battersea Vestry *v.* County of London, &c., Company].

In the course of his judgment, Mr. Justice Grantham said:—"I am of opinion that the defendants have power to break up the carriageway only. When the Act of 1870 was passed, no one ever dreamt of such a thing as an electric railway. . . . . Eminent persons have been called to show that it is better to lay electric cables used for the purpose of the tramways under the footways, and the Board of Trade, without thinking whether they have power to do so or not, have sanctioned that course, but that did not give the defendants power to open and break up the footways. The sooner an Act is passed to give promoters of tramways such a power the better. . . . . Here the defendants claim the right to do what they have done, and to do it again, whenever they choose. The plaintiffs are therefore justified in asking for an injunction. I am of opinion that the plaintiffs have suffered damages to the extent of £100, and I accordingly grant the injunction prayed for with £100 damages."

It is important to observe that powers to break up any street or bridge, &c., cannot be exercised without previous notice to the persons who have control of the same. Thus, by Section 8 of the Gasworks Clauses Act, 1847 (which is incorporated with the Electric Lighting Act, 1882, it is provided as follows:—

Before the undertakers proceed to open or break up any street, bridge, sewer, drain, or tunnel, they shall give to the persons under whose control or management the same may be, or to their clerk, surveyor, or other officer, notice in writing of their intention to open or break up the same, not less than three clear days before beginning such work, except in cases of emergency arising from defects in any of the pipes or other works, and then, so soon as is possible after the beginning of the work, or the necessity for the same shall have arisen.

The above section applies to undertakings in all parts of the country. With regard to undertakings outside the County of London, the Electric Lighting (Clauses) Act, 1899, now provides, by Section 14 of the Schedule, for notice to be given relating to any works which may involve interference with any street or public bridge.

Again, if a company or person obtains power by provisional orders to break up streets, the local authority of the district may claim to exercise the power under certain conditions. These may now be found in Clause 16 of the Schedule to the Electric Lighting Clauses Act, 1899.

### Liabilities of Undertakers.

The importance of obtaining express powers to break up or otherwise interfere with the highway lies in the fact that three remedies are open to the highway authority for any undue interference with the roadway. In the first place, to open and break up the soil and pavements of streets and bridges without express power constitutes a public nuisance, for which an indictment will lie [R. *v.* Langton Gas Company, 2 E. & E. 651; 6 Jur. (N.S.), 601, *sub. nom.* R. *v.* Knight]. The mere consent of the road authority does not legalise what would otherwise be a public nuisance. In the second place, an injunction may be obtained to restrain the breaking up of streets for the purpose of laying pipes; and this, although the works may have been completed before the commencement of proceedings (Goodson *v.* Richardson, 9 Ch. App. 221), but the Courts have generally refused to interfere where the damage is trivial. [Att. Gen. *v.* Sheffield Gas Consumer's Company, 3 De G., M. & G. 304; 22 L. J. Ch. 811; 17 Jur. 677.] Proceedings of this kind may also be taken by private individuals. [Stockport Dist. Water Company *v.* Corporation of Manchester, 9 Jur. (N.S), 266.]

Thirdly, penalties may be recovered under the Highway Act, 1835, 5 and 6 Will., 4 C. 50, Section 72 for breaking up streets without Parliamentary authority [Hawkins *v.* Robinson, 37 J.P. 662]. Penalties may also be recovered under the Public Health Act, 1875, Section 149.

With regard to proceedings for an injunction, it should be observed, in the first place, that the rights and privileges which are sought by an electric lighting company generally involve an interference with the *solum* of the street or highway. The *solum, usque admedium filum viae*, being usually vested in the adjoining landowners, it is often important to consider how far those adjoining owners can restrain interference with their property. As a first step, the landowner must establish his legal right to the soil, so that where an information and bill were filed complaining of the laying down of wires in tubes as an invasion of the rights of the landowner, an injunction was refused upon the ground that the legal title had not been established [Att. Gen. *v.* the United Kingdom Electric Telegraph Co., 30 Beav. 287]. It is not necessary, however, for him to show that the soil is of any value to him, or that his reason for seeking an injunction is in any way connected with his enjoyment of his land [Goodson *v.* Richardson, 9 Ch. App., 221].

Where interference with the soil is caused, or sanctioned by the roadway authority, different considerations arise, for the roadway authority or local board may have express or implied statutory authority to lay down wires, &c., for the purpose of lighting, &c. Thus, in the case of Fareham Local Board and Fareham Electric Lighting Company *v.*

Smith [7 T. L. R., 443], the local board contracted with the company to light a town. No license or provisional order from the Board of Trade or special Act had been obtained. The defendant was owner in fee of certain lands adjoining a public highway, and he alleged (1) that the poles and wires interfered with certain building operations on his land; (2) that he was entitled to remove the poles as owner of the subsoil of half the highway. On application being made, the late Mr. Justice Chitty granted an injunction to restrain him from so interfering, for the following reasons:—In the first place he said that as the highway in question was a "street" within the meaning of Section 149 of the Public Health Act, 1875, it was vested in the local board, who were entitled to more than the surface, and had further an area of user necessary for lighting their district. He also said:—"The local board has a proprietary right in the zone above the surface, or, at any rate, has a possession of so much above and so much below as falls within the objects of the Act. The electric lighting company has merely acted in pursuance of its contract, and is therefore not liable."

Secondly, he said that under the paragraph 1 of Section 161 of the Public Health Act, the Local Board were authorised to contract with any person for the supply of gas or other means of lighting the streets, markets, and public buildings in their district; further, that the restrictions contained in the subsequent paragraphs of Section 161 did not apply to lighting by other means than gas, but were only intended to prevent an urban authority from invading the district of a statutory gas company.

The above decision, which would appear to imply that the local or roadway authority has a certain interest in the sub-soil of the street or highway, must be read in conjunction with the following case, which was decided in the Court of Appeal on January 30th, 1899. There the defendants, an electric lighting company, wrongfully and without leave or license, opened and broke up a foot path in Trinity Road, Battersea, within the district of the Vestry of St. Mary. Upon the completion of the works the Vestry applied for a mandatory injunction. It having been decided that the completion of the works was no objection to the grant of an injunction [see Goodson *v.* Richardson (*ubi supra*)], it remained for the Court to see what rights of the plaintiffs were interfered with by the continuance of the wires in the place where they had been laid. By Section 96 of the Metropolis Local Management Act, 1855, "all streets being highways, and the pavements, stones, and other materials thereof, and all other things provided for the purposes thereof by any surveyor of highways, or by any person serving the office of surveyors of highways, or by any vestry or district board under this Act, shall vest in and be under the management and control of the vestry or district board of the parish or district in which such highways are situate." In the course of his judgment Lord Justice A. L. Smith said: "It is contended that the subsoil in which the wires are laid is vested in the plaintiffs. The answer to this is to be found in Mayor, &c., of Tunbridge Wells *v.* Baird [(1896) A. C. 434], where Lord Herschell said, at page 442: 'It seems to me that the vesting of the street vests in the urban authority such property, and such property only, as is necessary for the control, protection, and maintenance of the street as a highway for public use.' If this is all the plaintiffs have vested in them, they cannot maintain this action as owners of the subsoil. I come to the conclusion that they have not made out any right of theirs which can be interfered with by the continuance of the pipes and wires where they are." The above decisions might appear at first sight to be conflicting, but a little consideration will show that the former case merely decides that the road authority has power to break up or authorise the breaking up of roads, while the latter case proves that their property in the *solum* is not such as would enable them to prevent others from doing so.

Some doubt has arisen with regard to the question whether power to lay wires underground involves the right to break up the surface of the streets, and excavate the surface.

The case of the City of Montreal *v.* Standard Light and Power Company (1897, A.C. 527) although decided under a Colonial Act of Parliament, is very instructive. The respondents were incorporated in 1892 under the name of the St. Henri Light and Power Company by the Act 55 and 56 Vict., c. 77. It was only necessary to deal with four sections of that Act. Section 5 empowers the company (*inter alia*) to lay its wires . . . . underground as the same may be necessary, and in so many streets, &c., as may be necessary . . . . the whole without doing any unnecessary damage and providing all proper facilities for free passage through the said streets, &c., while the works are in progress. Section 18 is in the following terms:—"Before commencing the laying of wires or pipes or the erection of waterways, the company shall make a report to the Commissioners of Agriculture and Public Works of the province of such works and shall send a copy thereof to the council of the municipality in which such works are so projected."

By Section 6 of a subsequent Act, passed in 1893, it was provided that "the municipal council in all cities, towns, or incorporated villages, if they deem necessary, shall have the right to oversee and prescribe the manner in which . . . . streets, roads, and highways shall be opened . . . . for the placing of wires underground." The company sent a notification to the municipal council referring to the right of supervision reserved to the municipality, and intimating that they intended to exercise the powers conferred upon them for laying underground wires. They also made a report to the Commissioners of Agriculture and of Public Works, and sent a copy of the plan and report to the municipal council, requiring them, within 10 days, to prescribe the manner in which the streets mentioned in the report were to be opened, and stating that, in case of default, they would proceed with the works, taking all due precautions, &c.

No answer having been received from the municipal authorities, the respondent's workmen proceeded to break up the roads, whereupon the municipal authorities prevented them by force from continuing their operations. The respondents sued for and obtained an injunction against the city from interfering with their contractors and workmen, and the city appealed to the Privy Council. It was held that the power to open streets, that is, to break up their surface and excavate them, was plainly involved in Section 5, and that an injunction obtained by the respondents to restrain the municipality from interfering therewith was properly granted.

Under the London County Council (Subways Act, 1893, 56 and 57 Vict. c. ccii.) companies having power of opening and breaking up streets are, under the conditions referred to in Sections 3, 4 and 6, prohibited from doing so in a street where there is a subway; but by Section 24 it is provided that the Act "shall not apply to any pipe or wire authorised to be laid or placed by any provisional order or license under the Electric Lighting Acts, 1882 and 1888, or, under any special Act incorporating the said Acts, or (in respect of such wires) to any company authorised to lay or place the same." See also Metropolitan Subways Act, 1868 (31 and 32 Vict. c. lxxx.). In spite of the foregoing enactment a clause is usually inserted in County of London provisional orders enabling a county council or local authority to require electric lines to be laid in such subways rather than break up streets. [The form of a clause of this kind may be seen in Mr. Shiress Will's book on "The Law of Electric Lighting," 1898, p. 152].

## THE USE OF RUBBER INSULATED WIRE IN STEEL CONDUITS.

By V. ZINGLER, A.M.I.E.E.

A COMMITTEE of the Institution of Electrical Engineers is at present engaged on the by no means easy task of drawing up a set of rules and regulations to be observed in wiring buildings, which it is hoped will not only please everybody, but will also be accepted by everybody, and loyally adhered to. It is, perhaps, too much to expect that such an undertaking could be completed in a day, but it is to be hoped that the result will be known, let us say, during the present session.

In the meantime, house wiring is still going on under the old multiplicity of rules, conforming in part to all and

in whole to none; at the same time we hear of the gradual and systematic extension of the high voltage system by the electric supply authorities, which makes it all the more necessary to guard against breakdown of insulation in the future by added precautions in the present. In order to meet the possibility of accident and leakage by the increased pressure, an elaborate series of so-called high tension fittings have been designed and put on the market by makers of this class of article, many showing considerable ingenuity, and no doubt most being quite suitable for their purpose.

It seems, however, to the writer, that whilst so much attention has been given to accessories, an important point has been lost sight of, incidental to the largely increasing use of steel conduits for drawing the wires into, namely, the now recognised perishableness of vulcanised rubber. It is customary to attribute all the leakage on an installation to the fittings and lamps, and if a test is made on the wires only with freed ends, many hundreds of megohms will be reduced to units directly the fittings are connected. When wood casing only is used, the deterioration of the rubber after years does not become apparent if the casing remains dry, for the good reason that the wood is itself a fair insulator, and being dry, it prevents anything in the way of rot due to moisture hastening the destruction of the insulating qualities of the rubber, which may, at most, only crack.

In view of the now almost universal use of metallic conduits, it may be not inopportune at the present moment to inquire how far their use is a blessing in so far as the materials used for insulating the wires are concerned. The point is important, as those rules which have been framed up to the present make little or no mention of metallic (or conducting) conduits, and the precautions which should be adopted when using them. The fact that vulcanised rubber *per se* is perishable, and does not retain its chemical properties for many years, has long been known to rubber experts, but it is only lately that the matter has been brought home to electric supply authorities under the special conditions to which they have applied the rubber, by the wholesale breakdown of their cables all over the country, with the result that makers of rubber-covered cables have been obliged to manufacture lead-covered cables insulated with impregnated paper and other hygroscopic materials.

In continuation, therefore, of the above remarks with regard to rubber-covered cables in wood casing, as long as wood casing only is used, we see that no inconvenience is caused by the perishing of the rubber. When, however, the wires are drawn into metallic tubes—which not only conduct electricity but also heat—it is subjected to alternations of moisture and dryness, of heat and cold, which tend to still further shorten its life as an insulator; besides these troubles, if the conduit is such that moisture can get in besides that due to condensation, and chemical actions can take place, the rubber has still less chance. The conduit which is now largely used is nothing more than what is known as bedstead tubing, that is, steel tube with a mechanically *close* joint (not *closed*), japanned or enamelled by a firing process. A great deal of it is also obtained straight from the makers, and used in an untreated condition, as it can then be got for about half the price of the shiny article, and is put into damp lime plaster in that state. It will thus be seen that the tubing is not only not watertight, and is able to receive water and air from without, but it is also very often a prey to chemical action of a bad kind, which must have an effect on the rubber. It must also be borne in mind that the enamel is no insulator, but merely a temporary and not always homogeneous protection against rust.

It is not the object of these notes to decry this steel conduit; it admirably serves its purpose, that is, to act as a protection for the wires inside it, and the makers deserve all thanks for their enterprise in introducing a well standardised and cheap system for house wiring, which will, it is to be hoped, gradually abolish wood casing. It is not the conduit which now requires attention, but the covering of the wires drawn into it constitutes a real danger which was only potential in the case of wood casing.

Another important point also arises in connection with the use of rubber-covered wires in metallic conduits, namely, the question of joints. The original rules drawn up by the Institution of Electrical Engineers inform us that joints should be avoided as far as possible, as they constitute a weakness; but that if they are necessary they should be vulcanised. To consider first the necessity of joints. This depends entirely on the nature of the building to be wired, the system of wiring that is adopted, and the system of distribution. Whatever the last may be, the joints may only be avoided at each point (1) by looping the wires into the fittings, or (2) by running each point back to the board. If point switches are required it becomes necessary to have three terminals on each fitting. It will thus be seen that the extra wire used means extra expense, to say nothing of the labour.

If the wires are run in casing the actual extra cost of the latter is not great, and the labour of fixing, say, 6-inch casing to tap smaller sizes is very little more than that required to fix 1½-inch casing; also, the casing can, if necessary, go under the plaster, however reprehensible this practice may be. With wood casing, therefore, it may be said that the total extra cost for avoiding joints is not very great, and is worth paying for. There is, however, a limit in this direction when steel conduits are used, if every point has to be wired back to the fuseboard. It is now necessary to use a small tube for each pair of wires if we wish to keep below the plaster only, and this means considerably more in cost of material and labour, as well as wire. As an alternative, if boxes are used, the size of the pipes is increased, and it becomes necessary to chase the brickwork if appearances have to be considered, as is usually the case. All this is intended to show that if joints are to be avoided with steel conduit, the cost of wiring is largely increased, and it might therefore be deduced that, as our aim is always to cheapen the cost of wiring, joints should be used in reason if it is possible to get rid of their weakness.

Now, of the legitimate methods of making joints there are three: the pure rubber joint, the vulcanised joint, and the mechanical joint. The first is used universally in wood casing, where, if it is well made it is quite safe. It is also, unfortunately, being used in the same way with steel conduits in metallic boxes which collect moisture and other foreign matter. This practice is dangerous with 100-volt supply, but becomes doubly so at 200 volts, and should be discontinued. Pure rubber joints have absolutely no chance under the conditions of steel conduit wiring, and if soldered joints are to be used they should be vulcanised.

But here the contractor will say that the cost will be greatly increased, so that he might as well wire each point back to the fuseboard. Jointers who can vulcanise are not easy to get, and then every joint takes from twenty minutes to half-an-hour to make properly. In this matter the contractor must use his own judgment, depending on the class of building he has to wire, and many other conditions, but there is no doubt that, speaking generally, the fewer joints there are the better, and those few should be vulcanised.

As regards the question of mechanical joints, this has not received much attention, and, in the writer's opinion, the matter is capable of development. Porcelain bases with terminals in the metal boxes have been used, but this constitutes an even greater source of weakness than a soldered joint, as moisture condensing on the porcelain will put the metal work to earth at once. By mounting the metal terminals on impregnated or paraffined wood bases, and then thickly lacquering all the exposed metal work with the assistance of a blow flame, leakage might be avoided; but this is a matter for experiment. Or the wires may be brought into the joint boxes through glands (not of rubber) and the boxes filled with insulating oil. Again, the mechanical joints could be coated with some form of insulating paint, if the same could be guaranteed not to crack or corrode. To sum up, therefore, on the question of joints, if soldered joints are necessary they *must* be vulcanised; mechanical joints lend themselves to possibilities, and would no doubt be the cheapest form of wiring in the end. In order, therefore, to put house wiring on a firm, safe, and permanent basis, the attention of the inventor should be drawn to the questions of insulating material and joints. Might not those who are responsible for the drawing up of rules consider these questions in connection with the use of steel conduit, with a view to preventing the inevitable breakdowns which must occur in time, especially with 200 volts? Apart from the question whether there may or may not be a more *permanent* insulating material than rubber, even if it be not

such a *good* insulator, it cannot be too strongly urged that only the highest grade of rubber cables should be used, the wires being insulated with *pure* and vulcanised rubber, the latter to have the sulphur assimilated with it in the most careful way. The pure rubber, at any rate, serves to prevent the sulphur coming into conflict with the copper, which is one of the most frequent causes of the rotting of cables in the presence of moisture.

It may, perhaps, be argued that there is nothing to prevent the contractor from putting in inferior wire if he likes, but this can easily be got over by a judicious and impartial system of inspection by the supply authorities.

It amounts, therefore, to this—that the inferiority of rubber as a permanent insulator for wires drawn into metal tubes should be recognised; and that means should be taken to ensure the use of—if not another form of insulation—at any rate a better class of rubber than that which it has been customary to use for wood casing.

## NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

### NEW PATENTS.- 1899.

Compiled expressly for this Journal by W. P. THOMPSON & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

25,092. "Improvements in electric driving mechanism for geared machines generally." F. S. CARTER. Dated December 18th.

25,053. "Improvements in connectors for electrical wires or cables." T. R. BOWERBUTTS. Dated December 18th.

25,054. "An improved method for connecting tubular conduits with rectangular casings for electric conductors." G. H. CONGDON and F. MCCALLUM. Dated December 18th.

25,057. "Electric light magnifying bulbs or burners." O. D. DEACON. Dated December 18th.

25,079. "Electrolytic interrupter." F. DE MARE. Dated December 18th. (Complete.)

25,164. "Improvements in electric igniting devices for lighting gas and like lamps." E. SCHMIDT. Dated December 19th. (Complete.)

25,177. "Improvements in and relating to electrical illuminated advertisements." COUNT H. R. DE LAMBERTYE-TORNIELLE. Dated December 19th.

25,186. "Improvements in apparatus employed in wireless telegraphy." G. MARCONI and the WIRELESS TELEGRAPH AND SIGNAL COMPANY, LIMITED. Dated December 19th.

25,215. "New or improved insulating floor covering." G. E. HEYL-DIA. Dated December 20th.

25,216. "Improvements in electric cable conduits." G. E. HEYL-DIA. Dated December 20th.

25,254. "Improvements in the construction of reflectors or shades for electric or other lights." O. HOLT. Dated December 20th.

25,273. "A process for clearing the bulbs of incandescence osmium lamps." C. AUER VON WELSBACH. Dated December 20th.

25,274. "Process for clearing the bulbs of electric incandescent lamps." O. IMRAY. (J. LUX, Austria.) Dated December 20th.

25,275. "Improvements in or relating to clock-controlled electric switches." E. WEBSTER. Dated December 20th.

25,281. "Improvements in or relating to electrical traction particularly applicable for tramways and railways." H. LANE. Dated December 20th.

25,282. "Improvements in earthing devices and safety fuses for electrical circuits." L. J. STEELE. Dated December 20th.

25'295. "Improvements in electrical resistance measuring instruments." J. A. FLEMING. Dated December 20th. (Complete.)

25,346. "Improvements in perforators for use in connection with automatic telegraph transmitters." A. S. FRAMPTON and MUIRHEAD & Co. Dated December 21st.

25,347. "A new or improved method of measuring the difference of electric pressure between points of a circuit which may be distant from the observer and apparatus therefor." M. B. FIELD. Dated December 21st.

25,348. "Improvements in or connected with incandescent electric lamps." G. DAVIS. Dated December 21st.

25,350. "Improvements in electric incandescent lamps." V. SCHÖLZ. Dated December 21st.

25,353. "Improvements in liquid resistances for electrical circuits." E. F. MOY, P. H. BASTIE, and E. F. MOY, LTD. Dated December 21st.

25,362. "Improved method of telegraphing on telephone lines and telegraphic recorders for use in connection therewith." W. P. THOMPSON. (A. Sinding-Larsen, Norway). Dated December 21st. (Complete.)

25,366. "Improvements in electric incandescent lamp fittings or fasteners." S. B. APOSTOLOFF. Dated December 21st.

25,391. "Improvements in electrical measuring instruments." G. K. B. ELPHINSTONE and A. C. HEAP. Dated December 22nd.

25,396. "Electric trackway train." A. ST. VINCENT BURNABY. Dated December 22nd.

25,403. "An improved electric low-water alarm for steam generators." S. M. MATHEWS. Dated December 22nd. (Complete.)

25,407. "Improvements in holders for electric incandescent lamps." J. P. PHIBBS. Dated December 22nd.

25,413. "Improved means for insulating electric conductors." W. W. COLLEY. Dated December 22nd.

25,415. "Improvements in and relating to perforators for use in connection with automatic telegraph transmitters." G. DRAPER, K. C. COX, and J. JEFFERY. Dated December 22nd.

25,417. "Improvements in and relating to electro-magnets." L. J. DELAVEAU. Dated December 22nd.

25,420. "Improvements in alternating current induction motors." B. G. LAMME. Dated December 22nd. (Date applied for under Patents, &c., Act, 1883, Section 103, May 24th, 1899, being date of application in United States.)

25,421. "Improvements in alternating current generators." B. G. LAMME. Dated December 22nd. (Date applied for under Patents, &c., Act, 1883, Section 103, May 24th, 1899, being date of application in United States.)

25,422 "Improvements in systems of electrical distribution and circuit breakers for use therein." L. B. STILLWELL. Dated December 22nd. (Date applied for under Patents, &c., Act, 1883, Section 103, May 24th, 1899, being date of application in United States.)

25,423. "Improvements in electrical resistances." J. DULAIT and O. GARBE. Dated December 22nd.

25,426. "Improvements in or relating to electric arc lamps." D. J. BISSELL. Dated December 22nd.

25,432. "New or improved electrically-actuated air douche apparatus." A. M. THIERGARTNER. Dated December 22nd. (Complete.)

25,439. "A new or improved electrical contact apparatus." E. CADET and C. CHEVALLIER. Dated December 22nd.

25,446. "Improvements in electric railway motors." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (E. D. Priest, United States.) Dated December 22nd. (Complete.)

25,447. "Improvements in electric brakes." THE BRITISH THOMSON-HOUSTON COMPANY. (F. E. Case, United States.) Dated December 22nd. (Complete.)

25,448. "Improvements in safety devices for electric vehicles." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (F. E. Case, United States.) Dated December 22nd. (Complete.)

25,449. "Improvements in means for controlling electric motors." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. G. Davis and W. B. Potter, United States.) Dated December 22nd. (Complete.)

25,450. "Improvements in systems of electric train control." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (W. B. Potter, United States.) Dated December 22nd. (Complete.)

25,451. "Improvements in electric switches." THE BRITISH THOMSON-HOUSTON COMPANY. (E. Oxley, United States.) Dated December 22nd.

25,452. "Improvements in means for cooling electric brake shoes." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. Ekstrom, United States.) Dated December 22nd. (Complete.)

25,453. "Improvements in alternating current motor systems." THE BRITISH THOMSON-HOUSTON COMPANY, LIMITED. (A. G. Davis, United States.) Dated December 22nd. (Complete.)

25,464. "Improvements in electric alarms." M. WESCHER and P. WOLLENHAUPT. Dated December 23rd. (Complete.)

25,490. "Improvements in secondary batteries." M. A. P. MONNIER. Dated December 23rd.

25,491. "Improvements in accumulator batteries." P. MARINO. Dated December 23rd. (Complete.)

25,509. "Improvements in methods or means of insulating electric wires." B. G. HODGES, H. SMITH, and W. A. A. BURROWS. Dated December 23rd.

25,513. "Improvements in electric arc lamps." A. F. SPOONER. (P. Vassia, France.) Dated December 23rd.

25,514. "Improvements in telegraph relays," A. FRASER and G. DRAPER. Dated December 23rd.

### ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. THOMPSON and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

#### 1897.

**16,405. "Improvements relating to electric telegraphy." O. J. Lodge and A. Muirhead.** Dated July 10th, 1897. A receiving apparatus for Hertzian-wave signalling consists of a coherer arranged in circuit with the receiving instrument and a siphon recorder with means for causing the coherer to decohere. The coherer as shown consists of a metal spring secured at one end and having two adjustment screws, one of which produces the active contact. The coil of the recorder is shown attached by a fibre to the coherer to restore it to its normal state. The coherer may also be acted upon directly by a magnet, by a current-carrying wire in a magnetic field, by an oscillating toothed segment, or by a skew cam as described in Specification No. 11,069, A.D. 1894, acting on an extension of the coherer spring. When a filing coherer is employed it may be carried by the armature of a magnet in the local circuit. The following modifications are described in the provisional specification. Filing-coherers disturbed by the motion of a needle or moving coil receiving instrument may be used. A coherer having a mercury contact and a spiral surrounded by a helix of or containing iron may be used. A brush rubbing against a revolving drum may also be used as a coherer. As a decoherer a rod immersed in the filings and actuated by external means may be employed. As a wave emitter two spheres or ellipsoids may be employed, one having a depression containing oil, and the other a projection dipping therein. When automatic transmission is employed, the contacts caused by the perforations close the primary of the induction coil, the vibrating hammer being preferably kept in movement by an independent motor. As a system of relaying, the coherer circuit at an intermediate point can cause an induction coil to remit the signals received by the coherer. 6 claims.

**16,426. "An improved method of and means for employing electric traction on ropeways, railways, and like means of transit." J. W. White and H. White.** Dated July 12th, 1897. Relates to wire-ropeways with rope, electric, or other means of traction. Instead of continuous ropes the way is composed of a series of short ropes which are independently strained at the supporting posts. A supporting post for a wire ropeway with two ropes which are led over blocks to opposite sides of the post and there made fast and strained by any suitable arrangement. Rocking rails bridge the space between the ends of the rope. Electric railways and tramways on a block system. The wire ropeway described above is adapted for electric traction, but railways generally are also referred to in the provisional specification. Alternate rocking rails are permanently connected to a main conductor and are normally held tilted in one direction so that only alternate sections of the rope are alive. On the passage of a trolley, the rocking rail is tilted in the opposite direction and so held by an electro-magnet in series or otherwise while the trolley is taking current from that section, but is returned by a spring, &c., so as to leave that section dead when the trolley has passed over it. Other means of operating the switching-in arrangements may be employed. 2 claims.

**16,443. "Improvements in and relating to incandescence electric lamp sockets and holders." H. Bovis and J. Y. Fletcher.** Dated July 12th, 1897. Relates to incandescent lamps with parallel couplings. A connecting plug, which may be inserted in an ordinary lampholder, carries a holder for a lamp and a coupling with a removable plug and conductors by which a motor or other apparatus may be connected while the lamp is in use. 2 claims.

**16,488. "Improvements in cores for electrical machines." G. Westinghouse.** Dated July 12th, 1897. (Date claimed under Patents, &c., Act, 1883, Sec. 103, January 20th, 1897, being date of application in United States.) Relates to armatures and field magnets. A core for the stationary or rotating member of a dynamo or motor is composed of a casting having a cylindrical inner or outer surface, and provided with a flange at one end, against which the laminæ are pressed by an annular plate secured in position by a ring formed by running fusible metal into a pair of grooves in the casting and annular plate respectively. 2 claims.

**16,489. "Improvements in fastening means for core plates of electrical machines." E. E. Nolan.** Dated July 13th, 1897. (Date claimed under Patents, &c., Act, 1883, Sec. 103, January 20th, 1897, being date of application in United States.) Relates to armatures and field magnets. A core for the rotating or stationary member of a dynamo or motor is built up of laminæ supported by a cylindrical casting upon or within which they are held between a flange and an annular plate, the latter of which is secured in position by a spring metal ring, or segments of a ring, inserted into a circumferential groove in the casting. The annular plate may be formed with a shoulder to prevent displacement of the fastening ring. 3 claims.

**16,718. "Improvements in electrical recording instruments." H. L. Callendar.** Dated July 14th, 1897. Relates to potentiometers, Wheatstone bridges and recording electric currents. The contact slide of a straight wire bridge carries a pen to record its position continuously on travelling paper, and is automatically kept at a balance point on the wire by connections with two motors controlled by brakes, either of which may be released electro-magnetically by currents from a sensitive relay, this taking the place of the usual galvanometer. The relay may be a suspended coil, provided with an arm which has one or two ends making contacts with a wheel, or two such wheels. The wheel is slightly eccentric, and is rotated continuously between spring scrapers to keep the contacts clean and free. Or sliding contacts may be used, and the arm may be vibrated slightly by a fan for the same purpose. The slide may be moved by differential toothed gearing, or a gear. Pulleys are carried by the two motors, and the slide is connected to either of two pulleys which are carried by the ends of a cord passed round a spring-held pulley. The pulleys are connected by an endless cord. The bridge wire is supported on a frame consisting partly of metallic rods, and is shunted by a separate adjustable resistance. Connections are made with one end and the middle of the shunt when it is desired to have the zero point at the middle of the bridge wire; otherwise with the ends of the bridge. The apparatus may be used as a potentiometer or Wheatstone bridge for many purposes, including the recording of variations of difference of potential, current in a known resistance, temperature by a thermopile (applicable in walls of heat-engines cylinders), resistance wire, or mercury and wire thermometer, atmospheric, steam, and water pressures, differences of temperatures of two thermometers (applicable for hygrometry and radiometry), and alternating wave-forms, by using a contact-maker in the relay circuit. Alternating currents and potential differences may be recorded by applying them to the ends of two parallel resistances so as to heat them, the varying resistance thus caused between two other connections being recorded by the apparatus. The provisional specification mentions modification of the apparatus for measuring total electric quantity by making the slide move an intergrating-wheel over a uniformly rotating disc or cone, the wheel being connected with a counter, and also the use of the relay for submarine cable work. 5 claims.

**26,835. "Improvements in or relating to apparatus for indicating and registering variations of insulation resistance in electric networks and circuits generally." A. J. Boult. (M. Travailleur.)** Dated November 17th, 1897. The insulation resistance of an electric circuit is measured periodically during working by a recording voltmeter of high resistance. This is connected permanently between one main and the earth, and may be arranged to mark the difference of potential of these every five minutes. Some of these measurements are made while the voltmeter is shunted by a standard resistance; the difference of potential between the mains being constant, the difference between the readings of the voltmeter when shunted and not shunted is proportional to the insulation resistance between the whole circuit and earth. The voltmeter has fixed magnets and a movable coil carried between vertical pivots and connected with conducting spirals. The coil carries a long arm and an ink reservoir above a travelling paper drum. The arm carries another arm, movable vertically about a pivot and counterweighted: this arm is depressed periodically by a frame when a stylus on it passes through the ink and marks the paper. The frame is pivoted on the stand, counterweighted, and operated by an electro-magnet connected with the mains through contacts, and an arm of a clock switch, which may rotate once an hour. The same switch, by closing another circuit through an arm and contact plate, periodically excites an electro-magnet, the armature of which then closes the shunt circuit of the voltmeter for a time. The contact springs may be split plates, or flat spirals attached at their centres to the rotary arms. 3 claims.

**27,120. "Improvements in or connected with apparatus for electrically illuminating and displaying letters, numerials, devices, and the like, for advertising and decorative purposes." T. P. Martin.** Dated November 19th, 1897. Letters and numerals, &c., are formed on signboards and the like for advertisement purposes by lighting certain electric lamps of a series. There may be several groups of lamps and as many switch devices by which the lighting of the desired lamps is controlled. The switch devices and operating mechanism consist of the conductors carried on a block or board which is hinged, and is raised and lowered by crank levers operated from an electro-magnetic motor through a bar in connection with the armature of the same. On the blocks are mounted spring keys or bars having projections which make contact with the conductors to light certain lamps. The drums having perforations along the circumference to receive adjustable studs or projections, are rotated intermittently by the motor, the studs causing contact to be made between the keys and the conductors, by pressing on springs resting on the keys. In a modification, the keys are actuated through vertically moving lever bars. The intermittent movements are obtained by means of a cam on a shaft actuated by any suitable motor, the cam operating a lever which through a mercury switch makes and breaks the circuit of the electro-magnetic motor. 9 claims.

**27,129. "A new or improved electrolytic method of and apparatus for saponification." A. L. C. Noden, L. A. Bretonneau, and P. D. Shee.** Dated November 17th, 1897. Relates to a method of and apparatus for making soaps by electrolysis. Within the vat is a central revolving shaft having beaters with recesses and openings therein, and connected up to the negative pole of a source of electricity. Above the beaters is a porous vessel within which are cast-iron plates forming anodes. The upper beaters are provided with bundles of metallic threads forming brushes which keep clean the bottoms of the porous vessels. Oil, such as olive oil, is placed in the lower compartment, the lye in the upper vessel and the temperature raised to between 90°—100° C. by means of a heating coil. On passing the current, working at 2 to 4 volts with 100 amperes per cubic metre of the material used, soap is formed in about seven hours.

**27,145. "Improvements relative to the sun compass for rendering it suitable as correction apparatus directly connected with the magnetic compass." C. N. Eitrem.** Dated November 19th, 1897. The cross of the sun compass is attached to the bowl of the magnetic compass so that the line of the former coincides with the steering line of the latter. The card of the sun compass is mounted upon a sleeve fitted over the pivot of the cross, and on the shoulder is placed the bearing device, consisting of a ruler with a sight line, diopters, pointer, and hair line. The azimuth of the sun for a certain few minutes in advance of the time of the clock is first found, and having the azimuth by the local variation to the true magnetic bearing of the sun, the ruler is turned on the card as many degrees as the calculation shows, and is then clamped thereto by a nut. The clamped parts are then swung till the hair line coincides with the sight line in the ruler, and the indications on the card and magnetic compass card are read off and a comparison between the true and laid courses determine the deviation. A nut on the pivot is used to clamp the card when the sun compass issued as a bearing instrument only. 3 claims.

**27,208. "Improvements in ceiling rose and similar fittings for electric light service." A. E. Tanner.** Dated November 20th, 1897. Ceiling roses and like fittings may be constructed of an insulating base carrying projections forming four compartments, each to contain a connecting screw. Straight connection plates are passed through slots in the projections. In a modification the base carries one projection and has dovetail grooves to receive the connection plates. In either form the plates are secured by inserting screws through them into plain holes in the base. 1 claim.

**27,345. "Improvements in holders for incandescent electric lamps." G. Jaegar and H. Bender.** Dated November 22nd, 1897. Relates to holders for incandescent lamps. An ordinary brass holder contains a cylindrical insulator made with two square channels extending into it from opposite sides to receive two metal blocks. The insulator has also two round holes at right angles to the channels, to receive boxes which have hexagonal heads enabling them to be screwed into holes in the blocks. The boxes have internal lips and contain springs pressing out flanged contact plungers. The plungers are the only parts projecting from the insulator. The insulator has two small holes in the base through which the conducting wires are passed into the blocks, where they are secured by screws. 3 claims.

**27,346. "Improvements in holders for incandescent electric lamps." G. Jaegar and H. Bender.** Dated November 22nd, 1897. Relates to holders for incandescent lamps. An ordinary brass holder contains a cylindrical insulator such as is described in the preceding specification No. 27,345, A.D. 1897, except that the transverse channels are formed to receive round metal blocks. Each block has a half-round end, as shown in section, and into this part the plunger box is screwed, as shown in section. The projecting ends of the boxes are tapered. 3 claims.

**27,380. "Improvements in and relating to electrical cut-outs and fittings." G. M. Sellick.** Dated November 23nd, 1897. The covers of cut-outs and other fittings are secured in position by a screw or bolt made of porcelain, or the like non-conducting material, which engages with a threaded opening in the base. 1 claim.

**27,385. "Improvements in the manufacture of electric incandescent lamps." A. Wierre.** Dated November 22nd, 1897. (Date claimed under Patents, &c., Act, 1883, Section 103, September 25th, 1897, being date of application in France.) Relates to incandescent lamps. A filament is mounted on wires secured by glaze in a cap made of glass, porcelain, enamelled metal, or other material, two forms being described. The neck of a bulb is cut to fit in an annular recess in the cap. The neck and cap may be coated with platinum and copper or other metal, and connected by plumber's solder, lead glaze or enamel, or other fusible material. The cap is provided with a cross-pin to engage in a bayonet holder. The lamp may be repaired by removing the cap. 3 claims.

**27,387. "Electro-therapeutic exercising apparatus." A. Martin.** Dated November 22nd, 1897. (Date claimed under Patents, &c., Act, 1883, Sec. 103, May 10th, 1897, being date of application in France.) Relates to an electro-therapeutic apparatus, by the use of which, in addition to the muscles being mechanically exercised, the whole or any part of the human organism is subjected to electrical action proportional to the power developed. A frame supports a shaft, which can be rotated by a crank handle. On the shaft is a pulley around which a cord passes to the magneto-electric machine, the current from which is carried by cords to any desired part, as to hand grips on the handle. A brake drum is mounted on the shaft, and has brake shoes around which passes a cord, one end of which is attached to a spring balance, while the other end passes around a regulating pulley. The latter is adjustable by means of a notched lever, to vary the tension of the cord and spring balance. The number or revolutions is indicated upon a graduated dial, and a gong is sounded every tenth revolution. The pulley may be disconnected from the shaft so as to allow of the apparatus being used for exercising purposes only. 3 claims.

**27,398. "An improved means for indicating the duration of conversations in public telephones." A. Ewald and M. Friedlaender.** Dated November 22nd, 1897. Relates to apparatus for indicating the duration of telephone conversations, which restores the apparatus if the connection is not completed within a predetermined interval of time. A calling signal drops an indicator at the exchange, and closes the circuit of a magnet, which circuit is intermittently opened and closed by a pendulum. The armature carrying a pawl operates through the gear cam wheel. The wheel throws the lever forward so that its pawl moves the first indicator wheel one step; a stop for the lever is provided, and is carried by an oscillating lever, the other end of which bears against the end of the axle carrying the cam. When the lever moves under the action of a magnet, the stop is withdrawn, and the cam is released from the driving gear. This magnet is operated by ringing off. If the through connection is not obtained, the release of the lever and cam brings the indicator back to zero. 1 claim.

**27,430. "Improvements in fixed and portable electrically-driven circular, sawing, moulding, rebating, planing and surfacing machinery." G. Cameron.** Dated November 23rd, 1897. Relates to a portable support for sawing, rabbeting, planing and like machinery. A cast-iron base plate is fixed on a trolley. On this is mounted a revoluble plate which can be clamped at any required angle by hand screws working in concentric grooves. A circular saw or rotary planing cutters are mounted on the plate, and driven directly by an electro-motor. The invention is especially applicable in shipyards and other outdoor works. 1 claim.

**27,433. "Improvements in electric cables." G. H. Nisbett and D. Bates.** Dated November 23rd, 1897. Relates to electric conductors. Twin cables in which paper and air spa e insulation are employed are twisted into spiral form between the septa separating the conductors from each other. The intervening air space is obtained by means of a perforated strip of paper, by a bulbous edged or corrugated paper, or by a zig-zag or ladder of string. In further modifications, the paper insulation itself may be formed with narrow folds on the contiguous faces so as to form a separate air channel, or two strips of paper with narrow folded edges may have those edges placed together face to face, and may be inserted between the septa. 5 claims.

**27,483. "Improvements in electric arc lamps." W. H. Newall and A. W. Shout.** Dated November 23rd, 1897. Relates to arc lamps. A clutch for the upper carbon consists of two flat plates hinged end to end, a hole being formed in the abutting ends through which the carbon passes loosely. The outer ends of the plates are connected by links to a tube attached to the core of a solenoid. When the core is raised, it lifts the outer ends of the plates so that these grip and lift the carbon. Feeding occurs when the hinge is lowered to the base plate. Electric connection with the upper carbon is maintained by copper springs attached to the tube, and bearing against the carbon and the lamp frame. The lower carbon is carried by an insulated plate, supported by thin rods below another plate. Circular channels on these plates contain a ring of small glass tubes surrounding the arc. 3 claims.

**27,494. "Improvements in the method and means for regulation of alternating current systems." The British Thomson-Houston Company, Limited. (C. P. Steinmetz.)** Dated November 23rd, 1897. The regulation of sub-circuits is obtained by varying the relation between the current and the electromotive force producing the current. The variation is preferably obtained by the use of electro-dynamic phase modifiers such as synchronous motors, and the regulation is localised by the use of a source of out-of-phase waves of current. The alternator supplies current to the transformers in the sub-circuits. Connected with the mains is a phase modifier, the armature being in shunt and the field excited by a separate exciter. The field may be regulated in any desired way. Certain of the coils may be automatically shunted by the switch, operated by an electro-magnet. The regulation is localised by the self-induction appliance having an adjustable core. In the circuit the field of the phase modifiers may be varied by the automatically operated switch and the inductance is in shunt. 19 claims.

**27,496. "Improvements in dynamo-electric machines of the inductor type." The British Thomson-Houston Company, Limited. (C. P. Steinmetz.)** Dated November 23rd, 1897. Relates to alternating current dynamos of the inductor type. In order to prevent the formation of eddy currents in the solid part of the magnetic circuit, an auxiliary air gap is formed, between the solid yoke and the laminated armature teeth, and another between the yoke and inductor. The formation of eddy currents is further prevented by means of a short circuited or squirrel cage winding composed of a number of copper rods connected together at each end by a ring of low resistance metal. 6 claims.

**27,509. "A new or improved meter for electric current." J. Mehrle.** Dated November 23rd, 1897. Relates to energy meters. A pendulum carrying shunt coils and a contact-making spring oscillates in the field of a main current coil, and drives a counter by two curved teeth alternately acting on the teeth of a wheel. The pendulum is hung by two springs. The contact-maker consists of two stationary curved surfaces, separated by a diagonal insulating ridge, over which a light spring is carried by an extension of the pendulum, current being thus supplied to the coils alternately: the middle coil is permanently in the shunt circuit. In a modification the pendulum carries only the permanently connected shunt coil, being fixed at the sides of the series coil. The provisional specification refers to a contact-maker in which a metal ball rolls into a contact with two points alternately. 4 claims.